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Failure Mode and Effects Analysis (FMEA) Introductory Overview

TARDEC Systems Engineering Risk Management Team

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14. ABSTRACT
Purpose of presentation is to make you aware of a tool which is often misused if used at all. As result too many expensive failures go undiscovered until its too late. Unbelievable sums of money are spent annually in every industry to react to failures that were never anticipated. In most case these failures could have been avoided if the time was taken to identify them early. Therefore costs associated with controlling them would have gone from dollars to pennies relatively speaking.

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WELCOME

Welcome to

“An introductory overview of Failure Mode and Effects Analysis (FMEA)”,

A brief concerning the use and benefits of FMEA

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Why are you here?

The Cost of Poor Quality (COPQ) has been increasing at such a rate that there is almost nothing that "doesn't matter" when it comes to doing a good job. Whether it's the coffee we buy in the morning or the services we expect from government contractors, we'll only feel comfortable parting with our money if we felt it was worth it.

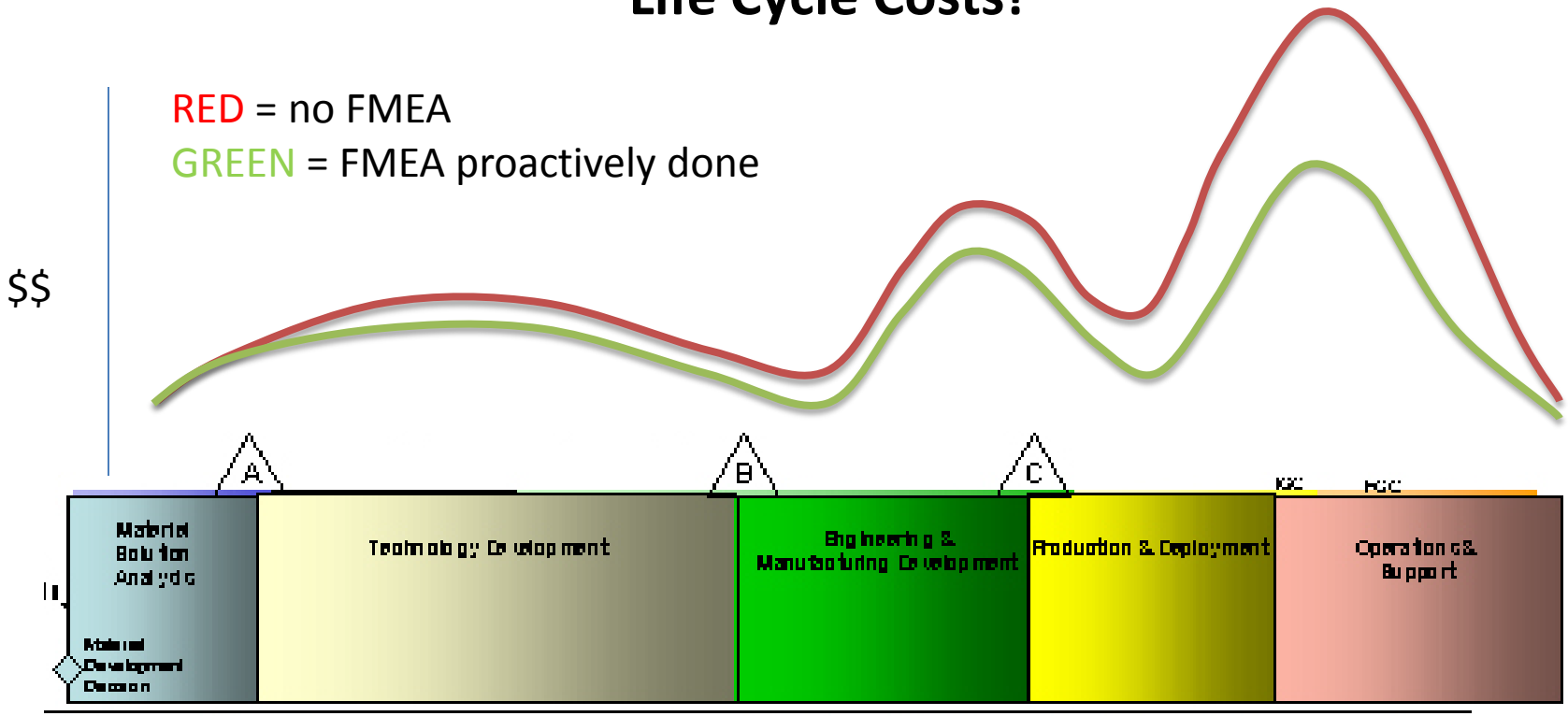
Today's goal is to show you the benefits of a powerful tool and how it PROACTIVELY…..

- **Identifies risk**
- **Focuses resources**
- **Reduces failure**
- **Reduces cost**
- **Improves safety**
- **and can be done by EVERY organization in ANY role**

This tool is **Failure Mode and Effects Analysis**

Why should you care?

Failure Mode and Effects Analysis can have SIGNIFICANT impact on Life Cycle Costs!



When correctly executed FMEA reduces costs by reducing the possibility of failure.

Doing it right the first time is always less expensive than the alternative.

BLUF Summary

When correctly executed FMEA reduces costs by reducing the possibility of failure.

FMEA can and does have SIGNIFICANT impact on Life Cycle Costs!

The FMEA never goes away, it only matures as a living document. Therefore it is both a proactive prevention tool as well as a reactive problem solving tool.

Industry has been using FMEA for a long time and has collaborated together to continuously improve the process.

Companies that ignore proactive tools like FMEA often fail!!

Failure Mode and Effects Analysis (FMEA)

A brief outline of the upcoming slides….

1. What is FMEA? Some definitions
2. How can FMEA help my program
3. When and Why use FMEA?
4. What can FMEA be used on?
5. How does FMEA work? – A simple example
6. Identifying and choosing the Top 5, 10, or 50 things to work on
7. Learning FMEA – sign up for our upcoming course
8. Wrap up

Today's overview is not a comprehensive explanation on the mechanics of FMEA!

This presentation is intended to make you aware of the power of being able to identify and deal with risk, but not to instruct you in detail. A live, instructional class has been constructed for that purpose and we hope you will take advantage of it.

What is FMEA?

FMEA stands for Failure Mode and Effects Analysis. Simply translated, it means that through some method we will identify how something can fail and what will happen if it does. When done correctly it can be an expedient and thorough approach to risk identification.

Some definitions:

1. ***Failure:*** *is the inability to produce the desired output. Failure may occur at any point within the function of a product or flow of a process.*

2. **Failure Mode:** the manner by which a failure is observed; it generally describes the way the failure occurs.

3. ***Effects:*** *the consequences of failure. The effect is the thing we are most interested in. The power of the effect will dictate our level of action. Not every failure will result in a severe effect and therefore not every failure needs to be addressed.*

4. ***Analysis:*** *means the investigation of the process being used such that it can be determined how failure occurs. The analysis provides identification of the potential failures and then serves to rate their effects based on how severe they are, how often they might occur, and how easily we can find them.*

By using FMEA we can eliminate problems BEFORE they happen and save time and money on prioritized work.

How Can FMEA Help My Program?

- A DFMEA provides robustness of design.
- A PFMEA provides robustness of process.
- A FMEA reused from a previous program reduces the design time for the system.
- Potential failure modes are identified early in the program and can be dealt with up front, rather than detected later.
- FMEAs can be used to determine the root cause of system or part failures, once fielded!!!

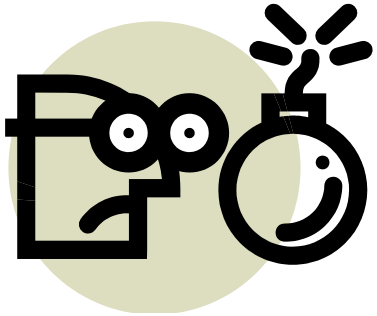
When and why should we use FMEA?

Manage RISK NOW!

PREVENT failure from occurring or minimize its effect by acting PROACTIVELY. Focus your efforts on the critical few items worth pursuing. Ensure SUCCESS by minimizing cost and reducing risk.

or….

Deal with FAILURE later



Lack of ANALYSIS leads to inefficient problem identification. Resources can be quickly expended addressing incorrect or insignificant concerns. The most severe failures may still happen and will always cost more to address reactively.

How can we use FMEA to our benefit?

Use it proactively to prevent failures

Explore the design and the processes of manufacturing and assembly to find the potential failures

Use the knowledge to put controls in place

Eliminate or diminish failures

Save time and money

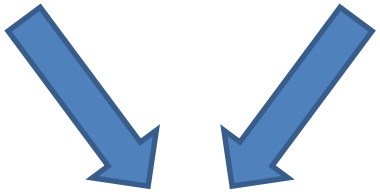
Use it reactively to solve problems

Interrogate the FMEA for similar or exact failures

Use the knowledge to put solutions in place

Eliminate or diminish failures

Save time and money



Update existing FMEAs with lessons learned and provide the basis for FAILURE FREE next generation ideas

What FMEA types exist?

Although FMEA is FMEA no matter its application, over the years many variations on the same theme were stood up under similar names. Here are some of the most popular categories:

Design FMEA – Helps to identify how something can fail to do what it was designed to do or why it does things it should not do

- Generates too much heat
- Takes too long to accelerate
- Cannot track target

Process FMEA – Helps to identify how something can be improperly or unsafely manufactured or assembled

- Parts missing after assembly
- Improper torque on fasteners
- Operator must put self at risk to achieve task

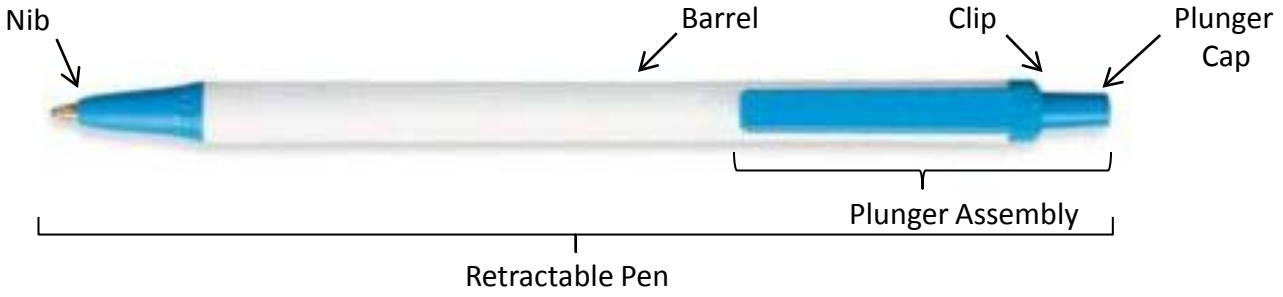
Transactional FMEA – Helps to identify the failures and inefficiencies of non-technical processes

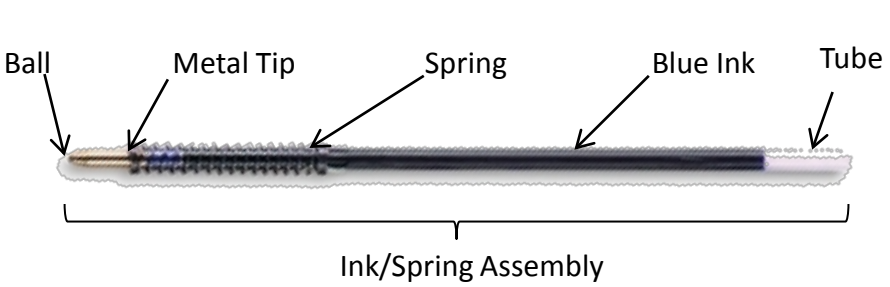
- Lack of expedient travel approval results in premium fares
- A lumbering hiring process hinders the ability to quickly address customer needs, resulting in more contracting and less self expertise

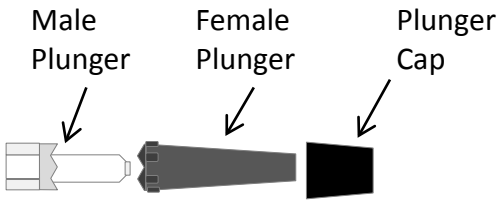
The retractable pen example

Every product has a function it was designed to perform. In addition most products also need to be manufactured or assembled. The failures that are encountered in each of these environments are completely different. Typically things are first designed for functionality before the manufacturing or assembly process is considered.

The retractable pen pictured below could fail to dispense ink or may break under the pressure of your hand. This would be a DESIGN failure. On the other hand if the pen is missing parts or put together incorrectly this may have been the result of a manufacturing or assembly PROCESS failure.







A Design FMEA example

This simple Design FMEA investigates the function of the ball in a ball point pen

Item #	Item name / Function	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Design Controls Prevention	Occurrence	Current Design Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
														Actions Taken	Severity	Occur	Detectio	R.P.N.
1.1.2.3	**Ball / deliver ink to paper**	**Not enough ink delivered to paper**	**Intermittent line / skipping**	7		Ball diameter variations	Tolerance specification	1	Supplier self certification and incoming inspection 10 of every lot	2	**14**							
				7		Paper surface finsh variation; too rough or too smooth	Paper surface finish range specification	6	No control	10	**420**	Study coefficient of friction vs ink delivery amount	**G. Ratajczak 11 Nov 2011**	**Study complete - must control ball surface finish**	7	1	10	**70**
				7		Ball surface finsh variation	Tolerance specification	2	Supplier self certification and incoming inspection 10 of every lot	2	**28**							
				7		Ball diameter too big; blocking flow of ink	Tolerance specification	1	Supplier self certification and incoming inspection 10 of every lot	2	**14**							
				7		User does not exert sufficient pressure	Force study done on users	5	Test: pressure vs ink delivery; 6 parts per month 0-6 psi	4	**140**							
				7		User holds pen at extreme angle	Grip angle study done on users	5	Test: angle vs ink delivery; 6 parts per month 0 - 90 degrees	4	**140**							
		No ink delivered to paper	**Ripped paper**	5		Ball diameter too big; blocking flow of ink	Tolerance specification	1	Supplier self certification and incoming inspection 10 of every lot	2	**10**							
		Too much ink delivered to paper	**Document ruined**	9		Ball diameter too small	Tolerance specification	1	Supplier self certification and incoming inspection 10 of every lot	2	**18**							
				9		User exerts excessive pressure	Force study done on users	5	Test: pressure vs ink delivery; 6 parts per month 0-6 psi	4	**180**							
				9		Improper hardness of ball material	Tolerance specification	2	Supplier self certification and incoming inspection 10 of every lot	2	**36**							

Most products will require both DESIGN and PROCESS FMEA. And since processes can often be comprised of ASSEMBLY and MANUFACTURNG, FMEA is appropriate in those areas as well.

BE THOROUGH – UNDERSTAND THAT THE FAILURES SEEN IN THE DESIGN ARE COMPLETELY DIFFERENT THAN THOSE THAT MIGHT OCCUR DUE TO MANUFACTURING OR ASSEMBLY!!

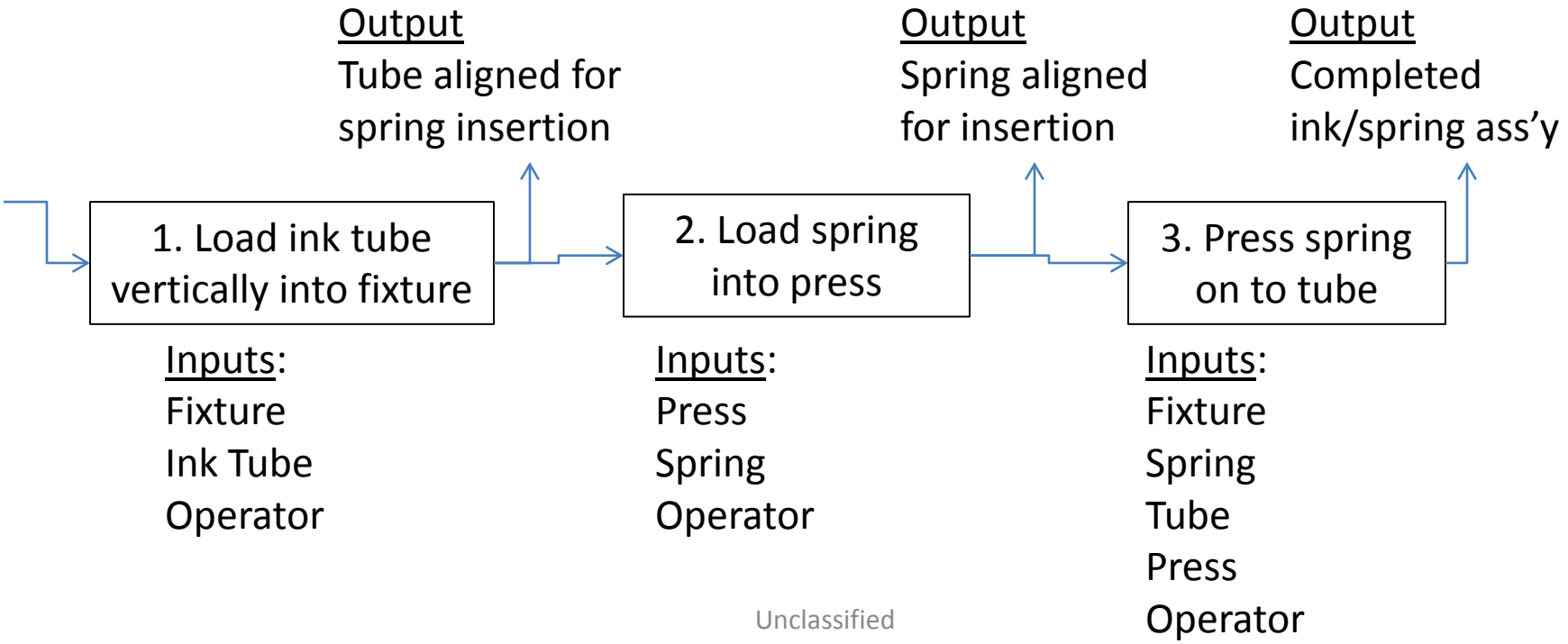
A Process FMEA Example

How does FMEA Work?

Step 1 - Understand how things work in order to find the ways it can fail.

Use proven, thorough approaches to describe all the elements of the process. Tools that describe how products function, or how processes work, turn complex things into elemental steps. Block Diagrams, Parameter (P) Diagrams, Work Breakdown Structures, and Process Maps are popular tools for this purpose.

In the example process map below we can envision three steps of the retractable pen assembly process as follows:



How does FMEA work?

Step 2 - Execute the analysis and discover the potential failures and effects, their causes, and ultimately what to do about it!

Process step #	Process step function / requirements	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
														Actions Taken	Severity	Occur	Detection	R.P.N.
1	Load ink tube vertically into fixture	Tube mis-aligned	Spring cannot be inserted	5		Fixture features/dimensions incorrect	Fixture drawings	3	Go/No Go Guage	2	30							
1	Load ink tube vertically into fixture	Tube mis-aligned	Spring cannot be inserted	5		Operator not trained	Work instructions	5	Visual inspection	7	175							
1	Load ink tube vertically into fixture	Tube missing	Spring cannot be inserted	5		Fixture features/dimensions incorrect (tube fell out)	Fixture drawings	3	In line sensor	2	30							
1	Load ink tube vertically into fixture	Tube missing	Spring cannot be inserted	5		Operator forgot to load tube	Visual inspection	6	No detection control	10	300	Install sensor to detect tube	G. Ratajczak 07/MAR/2012	Sensor installed at ST001	5	6	2	22
2	Load spring into press	Spring mis-aligned	Spring cannot be inserted	5		Press features/dimensions incorrect	Fixture drawings	3	In line sensor	2	30							
2	Load spring into press	Spring mis-aligned	Spring cannot be inserted	5		Operator not trained	Work instructions	5	Visual inspection	7	175							
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2	Load spring into press	Spring missing	Spring cannot be inserted	5		Operator forgot to load spring	Visual inspection	6	No detection control	10	300	Install sensor to detect spring	G. Ratajczak 07/MAR/2012	Sensor installed at ST002	5	6	2	22
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall off in a later step	7		Press does not move far enough down	Position sensors	1	Visual inspection	8	56							
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall off in a later step	7		Operator did not activate press	Visual reminder (green light)	6	No detection control	10	420	Install position sensor at full travel	G. Ratajczak 07/MAR/2012	Sensor installed at ST003	7	6	2	84
3	Press spring on to tube	Spring pressed on to tube too far	Ink/tube may not retract/extend	10	KPP	Press travel incorrect	Hard stop on press	1	Optical sensor	4	40							
3	Press spring on to tube	Spring not on tube at all	Rework needed	8		Spring fell off of press while moving downward	Part orientation	4	Visual inspection	8	256							
3	Press spring on to tube	Spring pressed on incorrectly	Ink/tube may not retract/extend	10	KPP	Fixture/press aligment issue	Verify alignment at each shift	2	Hourly audits	6	120							
3	Press spring on to tube	Spring pressed on incorrectly (crooked)	Ink/tube cannot be inserted into housing	5		Fixture/press aligment issue	Verify alignment at each shift	2	Hourly audits	6	60							

Both Design and Process FMEAs are created by using a step by step method. Let's go through the PFMEA pictured above one section at a time…..

How does FMEA work?

Process step #	Process step function / requirements	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
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1	Load ink tube vertically into fixture	Tube mis-aligned	Spring cannot be inserted	5		Fixture features/dimensions incorrect	Fixture drawings	3	Go/No Go Guage	2	30							
1	Load ink tube vertically into fixture	Tube mis-aligned	Spring cannot be inserted	5		Operator not trained	Work instructions	5	Visual inspection	7	175							
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2	Load spring into press	Spring mis-aligned	Spring cannot be inserted	5		Press features/dimensions incorrect	Fixture drawings	3	In line sensor	2	30							
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2	Load spring into press	Spring missing	Spring cannot be inserted			Press features/dimensions					30							
2	Load spring into press	Spring missing	Spring cannot b inserted										to G. Ratajczak 07/MAR/2012	Sensor installed at ST002	5	6	2	22
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall of a later step															
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall of a later step										travel G. Ratajczak 07/MAR/2012	Sensor installed at ST003	7	6	2	84
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3	Press spring on to tube	Spring not on tube at all	Rework needed															
3	Press spring on to tube	Spring pressed on incorrectly	Ink/tube may nc retract/extend															
3	Press spring on to tube	Spring pressed on incorrectly (crooked)	Ink/tube cannot inserted into housing															

Process step #	Process step function / requirements
1	Load ink tube vertically into fixture

How does FMEA work?

Process step #	Process step function / requirements	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
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2	Load spring into press	Spring missing	Spring cannot be			Press features/dimensions					30							
2	Load spring into press	Spring missing	Sp										tajczak R/2012	Sensor installed at ST002	5	6	2	22
3	Press spring on to tube	Spring not fully pressed on to tube	Spr															
3	Press spring on to tube	Spring not fully pressed on to tube	Spr										tajczak R/2012	Sensor installed at ST003	7	6	2	84
3	Press spring on to tube	Spring pressed on to tube too far	In															
3	Press spring on to tube	Spring not on tube at all	R															
3	Press spring on to tube	Spring pressed on incorrectly	In															
3	Press spring on to tube	Spring pressed on incorrectly (crooked)	Ink															

Potential Failure Mode	Potential Effects of Failure	Severity
Tube mis-aligned	Spring cannot be inserted	5

How does FMEA work?

Process step #	Process step function / requirements	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
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3	Press spring on to tube	Spring pressed on to tube too far	Ink/tube retract/															
3	Press spring on to tube	Spring not on tube at all	Rework															
3	Press spring on to tube	Spring pressed on incorrectly	Ink/tube retract/															
3	Press spring on to tube	Spring pressed on incorrectly (crooked)	Ink/tube inserte hou															

Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence
Fixture features/dimensions incorrect	Fixture drawings	3

How does FMEA work?

Process step #	Process step function / requirements	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
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3	Press spring on to tube	Spring pressed on incorrectly	Ink/tube may not retract/extend	10	KP													
3	Press spring on to tube	Spring pressed on incorrectly (crooked)	Ink/tube cannot be inserted into housing	5														

Current Process Controls Detection	Detect
Go/No Go Guage	2

How does FMEA work?

Process step #	Process step function / requirements	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
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1	Load ink tube vertically into fixture	Tube missing	Spring cannot be inserted	5		Fixture features/dimensions incorrect (tube fell out)	Fixture drawings	3	In line sensor	2	30							
1	Load ink tube vertically into fixture	Tube missing	Spring cannot be inserted	5		Operator forgot to load tube	Visual inspection	6	No detection control	10	300	Install sensor to detect tube	G. Ratajczak 07/MAR/2012	Sensor installed at ST001	5	6	2	22
2	Load spring into press	Spring mis-aligned	Spring cannot be inserted	5		Press features/dimensions incorrect	Fixture drawings	3	In line sensor	2	30							
2	Load spring into press	Spring mis-aligned	Spring cannot be inserted	5		Operator not trained	Work instructions	5	Visual inspection	7	175							
2	Load spring into press	Spring missing	Spring cannot be inserted	5		Press features/dimensions incorrect (spring fell out)	Fixture drawings	3	In line sensor	2								
2	Load spring into press	Spring missing	Spring cannot be inserted	5		Operator forgot to load spring	Visual inspection	6	No detection control	10			Ratajczak MAR/2012	Sensor installed at ST002	5	6	2	22
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall off in a later step	7		Press does not move far enough down	Position sensors	1	Visual inspection	8								
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall off in a later step	7		Operator did not activate press	Visual reminder (green light)	6	No detection control	10			Ratajczak MAR/2012	Sensor installed at ST003	7	6	2	84
3	Press spring on to tube	Spring pressed on to tube too far	Ink/tube may not retract/extend	10	KPP	Press travel incorrect	Hard stop on press	1	Optical sensor	4								
3	Press spring on to tube	Spring not on tube at all	Rework needed	8		Spring fell off of press while moving downward	Part orientation	4	Visual inspection	8								
3	Press spring on to tube	Spring pressed on incorrectly	Ink/tube may not retract/extend	10	KPP	Fixture/press aligment issue	Verify alignment at each shift	2	Hourly audits	6								
3	Press spring on to tube	Spring pressed on incorrectly (crooked)	Ink/tube cannot be inserted into housing	5		Fixture/press aligment issue	Verify alignment at each shift	2	Hourly audits	6								

R.P.N.

30

Risk Priority Number (RPN)

RPN = 5 x 3 x 2 = 30

Out of a possible 10 x 10 x 10 = 1000

this risk ranks relatively low.....

How does FMEA work?

Process step #	Process step function / requirements	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
														Actions Taken	Severity	Occur	Detection	R.P.N.
1	Load ink tube vertically into fixture	Tube mis-aligned	Spring cannot be inserted	5		Fixture features/dimensions incorrect	Fixture drawings	3	Go/No Go Guage	2	30							
1	Load ink tube vertically into fixture	Tube mis-aligned	Spring cannot be inserted	5		Operator not trained	Work instructions	5	Visual inspection	7	175							
1	Load ink tube vertically into fixture	Tube missing	Spring cannot be inserted	5		Fixture features/dimensions incorrect (tube fell out)	Fixture drawings	3	In line sensor	2	30							
1	Load ink tube vertically into fixture	Tube missing	Spring cannot be inserted	5		Operator forgot to load tube	Visual inspection	6	No detection control	10	300	Install sensor to detect tube	G. Ratajczak 07/MAR/2012	Sensor installed at ST001	5	6	2	22
2	Load spring into press	Spring mis-aligned	Spring cannot be inserted	5		Press features/dimensions incorrect	Fixture drawings	3	In line sensor	2	30							
2	Load spring into press	Spring mis-aligned	Spring cannot be inserted	5		Operator not trained	Work instructions	5	Visual inspection	7	175							
2	Load spring into press	Spring missing	Spring cannot be inserted	5		Press features/dimensions incorrect (spring fell out)	Fixture drawings	3	In line sensor	2	30							
2	Load spring into press	Spring missing	Spring cannot be inserted	5		Operator forgot to load spring	Visual inspection	6	No detection control	10	300	Install sensor to detect spring	G. Ratajczak 07/MAR/2012	Sensor installed at ST002	5	6	2	22
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall off in a later step	7		Press does not move far enough down	Position sensors	1	Visual inspection	8	56							
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall off in a later step	7		Operator did not activate press	Visual reminder (green light)	6	No detection control	10	420	Install position sensor at full travel	G. Ratajczak 07/MAR/2012	Sensor installed at ST003	7	6	2	84
3	Press spring on to tube	Spring pressed on to tube too far	Ink/tube may not retract/extend	10	KPP	Press travel incorrect	Hard stop on press	1	Optical sensor	4	40							
3																		
3																		
3																		

Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.
Spring may fall off in a later step	7		Operator did not activate press	Visual reminder (green light)	6	No detection control	10	420

RPN = 7 x 6 x 10 = 420 !!! The analysis says this failure, along with its severe effect, is not only likely to happen, but we currently have no way to detect it!

How does FMEA work?

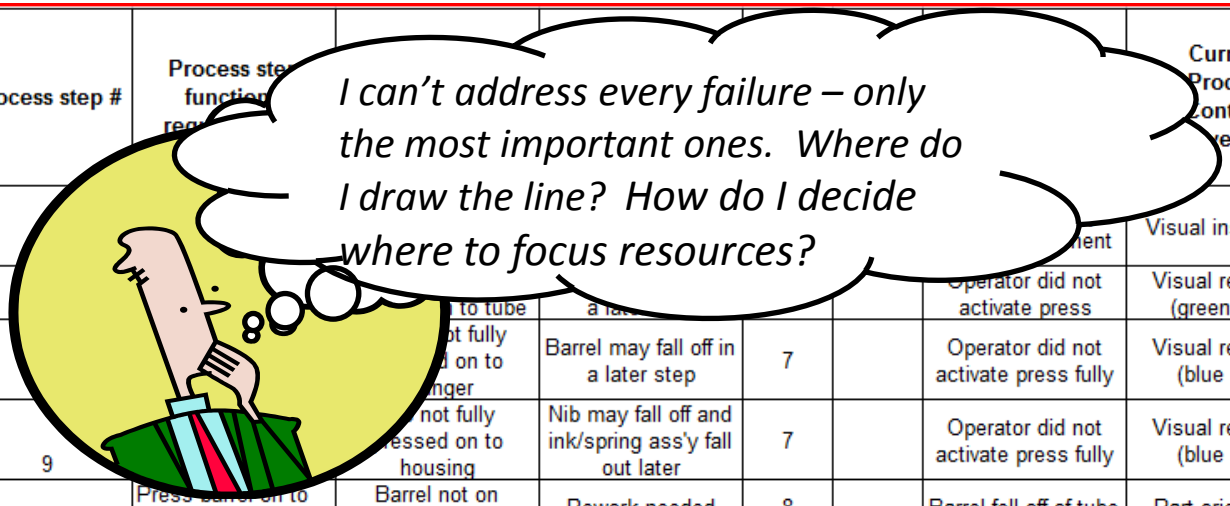
Process step #	Process step function / requirements	Potential Failure Mode	Potential Effects of Failure	Severity	Classification	Potential Causes / Mechanisms of Failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.	Recommended Actions	Responsibility & Target Completion Date	Action Results				
														Actions Taken	Severity	Occur	Detection	R.P.N.
1	Load ink tube vertically into fixture	Tube mis-aligned	Spring cannot be inserted	5		Fixture features/dimensions	Fixture drawings	3	Go/No Go Guage	2	30							
1	Load ink tube vertically into fixture	Tub																
1	Load ink tube vertically into fixture	T																
1	Load ink tube vertically into fixture	T												ed at	5	6	2	22
2	Load spring into press	Spr																
2	Load spring into press	Spr																
2	Load spring into press	S																
2	Load spring into press	S	inserted			load spring						detect spring	07/MAR/2012	ST002				
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall off in a later step	7		Press does not move far enough down	Position sensors	1	Visual inspection	8	56							
3	Press spring on to tube	Spring not fully pressed on to tube	Spring may fall off in a later step	7		Operator did not activate press	Visual reminder (green light)	6	No detection control	10	420	Install position sensor at full travel	G. Ratajczak 07/MAR/2012	Sensor installed at ST003	7	6	2	84
3	Press spring on to tube	Spring pressed on to tube too far	Ink/tube may not retract/extend	10	KPP	Press travel incorrect	Hard stop on press	1	Optical sensor	4	40							
3	Press spring on to tube	Spring not on tube at all	Rework needed	8		Spring fell off of press while moving downward	Part orientation	4	Visual inspection	8	256							
3	Press spring on to tube	Spring pressed on incorrectly	Ink/tube may not retract/extend	10	KPP	Fixture/press aligment issue	Verify alignment at each shift	2	Hourly audits	6	120							
3	Press spring on to tube	Spring pressed on incorrectly (crooked)	Ink/tube cannot be inserted into housing	5		Fixture/press aligment issue	Verify alignment at each shift	2	Hourly audits	6	60							

Recommended Actions	Responsibility & Target Completion Date	Action Results				
		Actions Taken	Severity	Occur	Detection	R.P.N.
Install position sensor at full travel	G. Ratajczak 07/MAR/2012	Sensor installed at ST003	7	6	2	84

One of several potential actions lowers the risk level

By adding detection controls that do not allow the cause to happen, the risk is mitigated in a very real way.

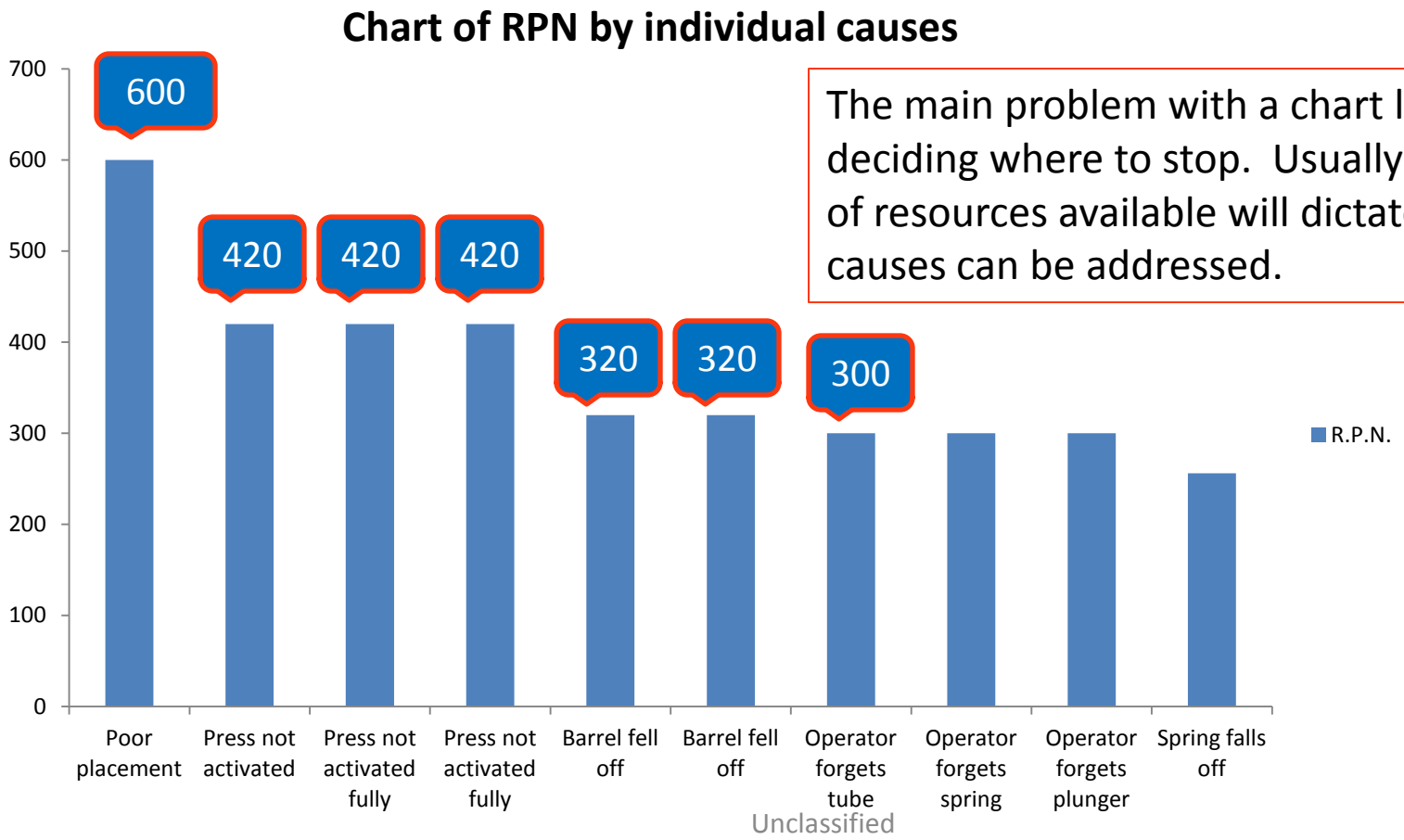
Take action where needed
Sorting by RPN



Process step #	Process step function requirement	Potential failure mode	Potential failure effects	Severity	Classification	Potential cause(s) of failure	Current Process Controls Prevention	Occurrence	Current Process Controls Detection	Detect	R.P.N.
						ment	Visual inspection	6	No detection control	10	600
		to tube	a la			Operator did not activate press	Visual reminder (green light)	6	No detection control	10	420
		ot fully d on to nger	Barrel may fall off in a later step	7		Operator did not activate press fully	Visual reminder (blue light)	6	No detection control	10	420
9		not fully essed on to housing	Nib may fall off and ink/spring ass'y fall out later	7		Operator did not activate press fully	Visual reminder (blue light)	6	No detection control	10	420
6	Press [illegible] on to plunger	Barrel not on plunger at all	Rework needed	8		Barrel fell off of tube	Part orientation	4	No detection control	10	320
9	Press nib on to housing ass'y	Nib not on housing at all	Rework needed	8		Barrel fell off of tube	Part orientation	4	No detection control	10	320
1	Load ink tube vertically into fixture	Tube missing	Spring cannot be inserted	5		Operator forgot to load tube	Visual inspection	6	No detection control	10	300
2	Load spring into press	Spring missing	Spring cannot be inserted	5		Operator forgot to load spring	Visual inspection	6	No detection control	10	300
4	Load plunger ass'y to fixture	Plunger ass'y missing	Housing cannot be added	5		Operator forgot to load plunger ass'y	Visual inspection	6	No detection control	10	300
5	Load barrel on to press	Barrel mis-aligned	Housing cannot be added	5		Operator forgot to load barrel	Visual inspection	6	No detection control	10	300
3	Press spring on to tube	Spring not on tube at all	Rework needed	8		Spring fell off of press while moving downward	Part orientation	4	Visual inspection	8	256
4	Load plunger ass'y to fixture	Plunger ass'y mis-alignned	Housing cannot be added	5		Operator not trained	Work instructions	5	No detection control	10	250
5	Load barrel on to press	Barrel mis-aligned	Housing cannot be added	5		Operator not trained	Work instructions	5	No detection control	10	250
1	Load ink tube vertically into fixture	Tube mis-aligned	Spring cannot be inserted	5		Operator not trained	Work instructions	5	Visual inspection	7	175
2	Load spring into press	Spring mis-aligned	Spring cannot be inserted	5		Operator not trained	Work instructions	5	Visual inspection	7	175
3	Press spring on to tube	Spring pressed on incorrectly	Ink/tube may not retract/extend	10	KPP	Fixture/press aligment issue	Verify alignment at each shift	2	Hourly audits	6	120
6	Press barrel on to plunger	Barrel pressed on incorrectly	Damaged parts/Scrap	8		Fixture/press aligment issue	Verify alignment at each shift	2	Hourly audits	6	96

Take action where needed

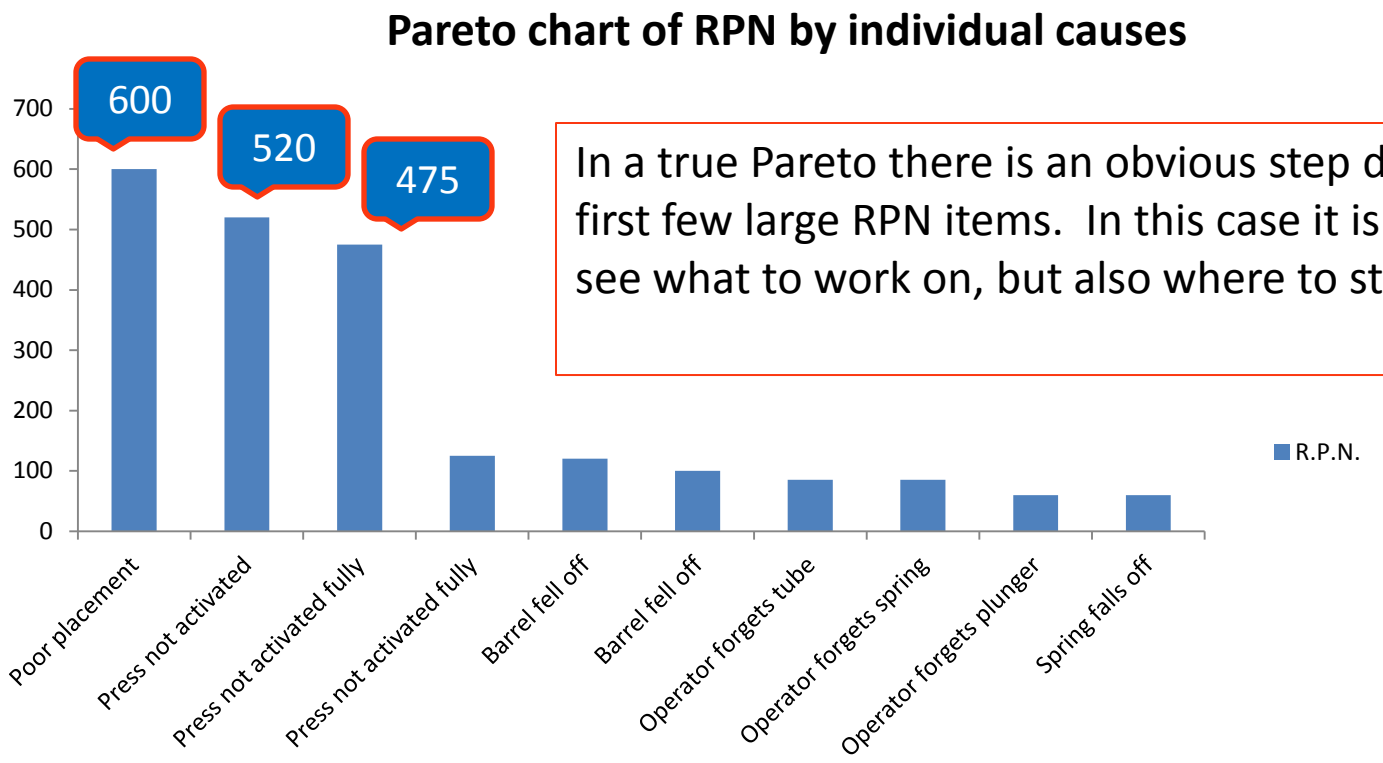
A chart can be made of RPN versus cause. Without a Pareto, the easiest way to decide what to work on is to simply sort by RPN and address the highest items. In a simple rank order chart the RPN falls (descends) by even, somewhat linear steps.



The main problem with a chart like this is deciding where to stop. Usually the amount of resources available will dictate how many causes can be addressed.

Take action where needed

If a Pareto exists, then the 80/20 rule starts to apply, meaning that the majority of our concern can be eliminated by addressing the relatively few but very potent top items.

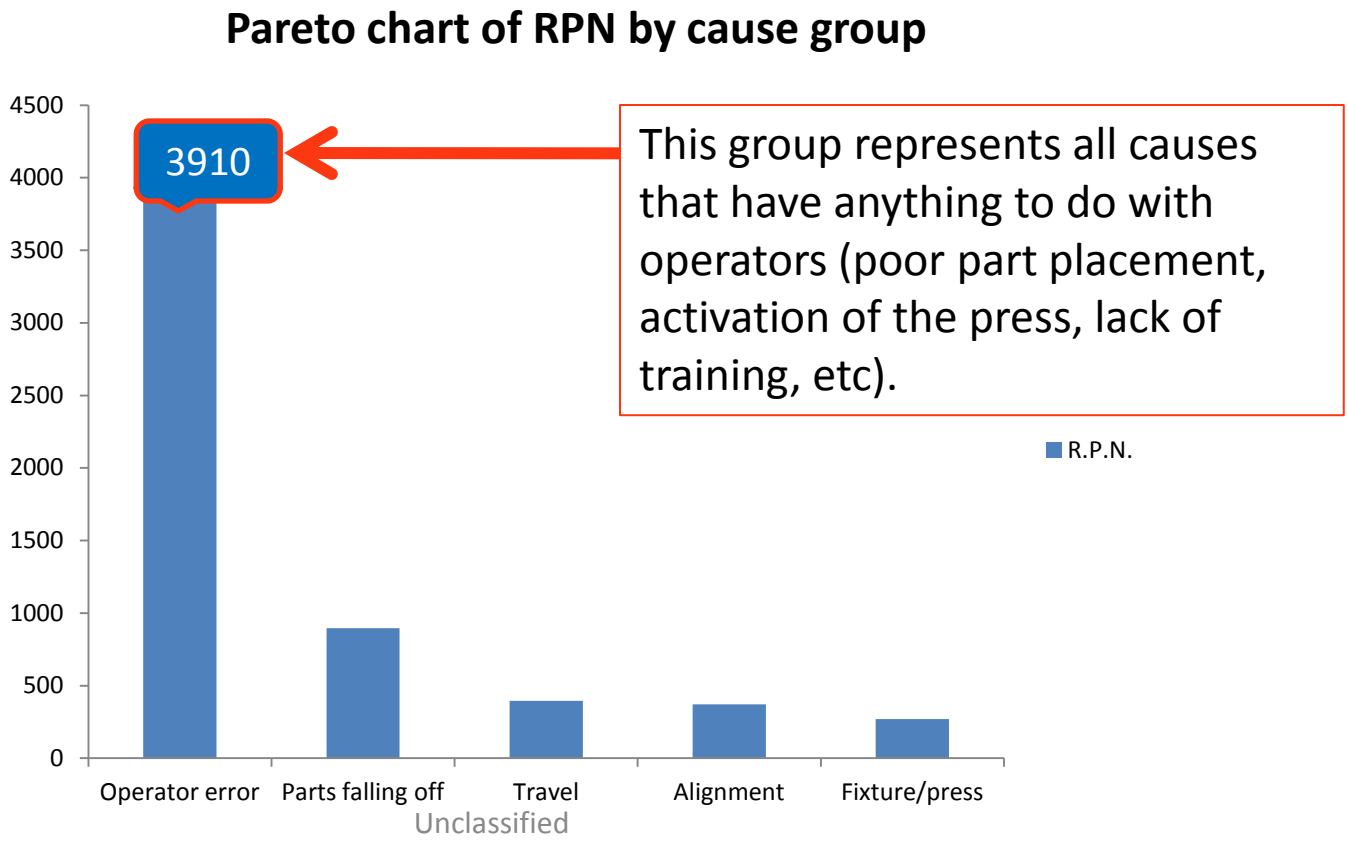


In a true Pareto there is an obvious step down after the first few large RPN items. In this case it is not only easy to see what to work on, but also where to stop working.

Take action where needed

If another way is desired to identify a Pareto and get the most risk mitigation for the money, causes that are similar and that might receive the same controls can be grouped. This is a “kill many birds with the same stone” approach. Cause groups are comprised of many similar causes found throughout the entire FMEA. Individually their RPN rankings might be low, but when combined into a group they can add up substantially.

Addressing anything that has to do with “operator error” has a HUGE impact!



Apply FMEA to EVERYTHING

In the retractable pen example, it was easy to see how the assembly process could fail to produce a properly put together pen. The PROCESS FMEA showed:

- Each assembly process step has some output and therefore a way to fail
- By carefully mapping the process, the potential failures become visible and controllable

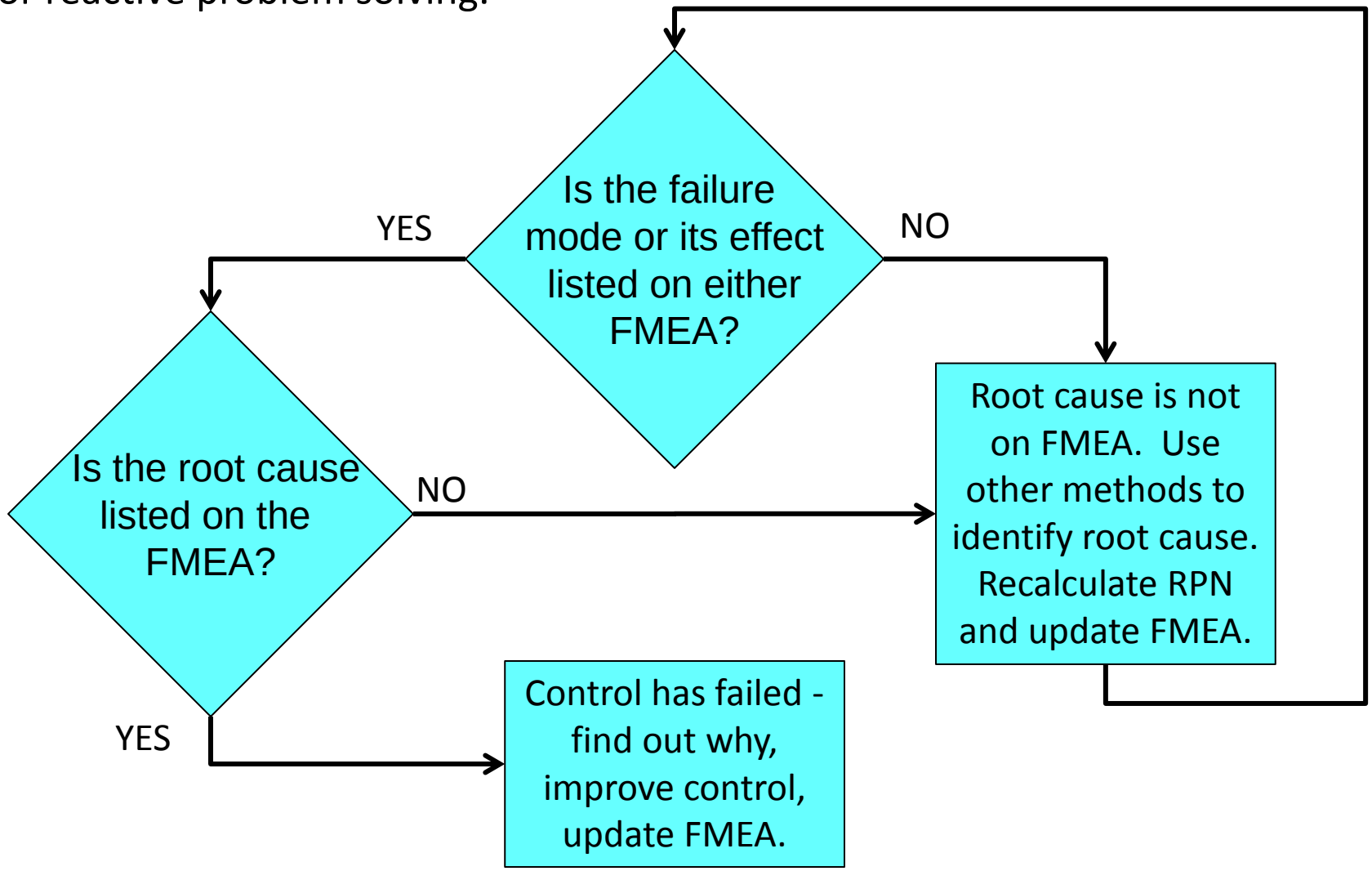
However, just because something is properly assembled does not mean that it will not fail! The way things are designed plays a large role in how robust they are to failure. A full DESIGN FMEA could have shown us the risk of failure due to poor design and engineering:

- Poor designs can make things work improperly, inefficiently, or not at all
- By understanding how things work and how they interface, failure modes become visible and controllable

Risk reduction by executing FMEA is not complete until ALL aspects of risk have been addressed. A DESIGN FMEA followed by a PROCESS FMEA insures that products will work as expected and be put together as expected. Together they identify the deviations to design and process expectations which result in failures.

Using FMEA for Root Cause Analysis

In the event that a failure mode is encountered, the FMEA can be the first source for reactive problem solving.



Government Contracts and FMEA

Many government products are designed, manufactured, and assembled by contractors through written contracts.

We have learned that without some structured approach to reducing risk, such as FMEA, failures with various levels of effect can and will result. This is unacceptable to the Warfighter.

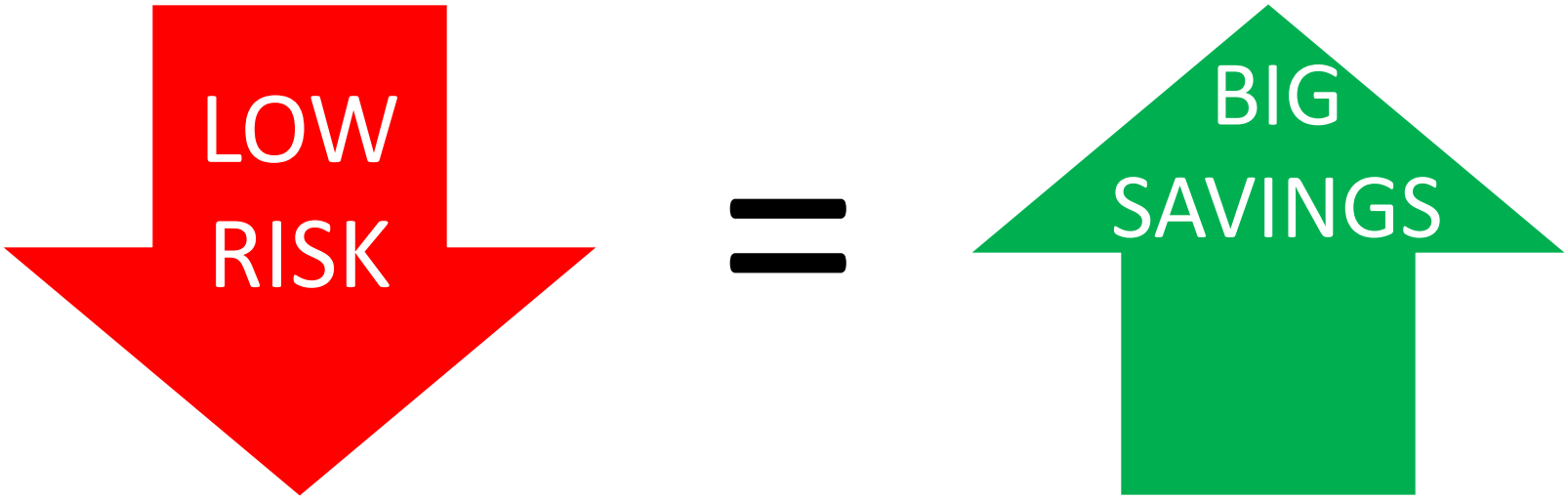
Therefore the Government should expect contractors to complete any and all appropriate FMEAs needed to risk reduce a product.

Government contracts need to be written such that the FMEA and its supporting documents will be shared and audited by the Government. This will insure that failures are minimized, and costs stay within expectations.

Recommend using TARDEC FMEA Templates, Ranking Tables with two scales, and DFMEA & PFMEA Evaluation Check Lists customized to DoD systems.

Less risk = less failure = less cost

Successful FMEA exercises result in very complete risk identifications. In turn, risk management is more successful in eventually reducing the failures which were identified as the most influential.



SUMMARY:

1. FMEA is not hard to do or understand
2. FMEA works on EVERYTHING
3. FMEA is the BEST way to identify risk
4. Managing risk early SAVES MONEY!

ARE YOU USING FMEA? CAN YOU AFFORD NOT TO?

UPCOMIN TARDEC FMEA TRAINING

Understanding and Evaluating Failure Mode and Effects Analysis (FMEA)

Insert information concerning upcoming class, times, how to sign up.

Class will cover:

How to prepare for FMEA using the proper tools, How to do FMEA, Design and Process FMEAs with examples and exercises, Prioritization of mitigation actions, Using FMEA to root cause failures, Transition to Project Recon, Evaluating and Managing Contractor FMEA, TARDEC FMEA Templates, Ranking Tables with two scales, and DFMEA & PFMEA Evaluation Check Lists customized to DoD systems

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Lisa.J.Graf2.civ@mail.mil

Need minimum of 15 enrolled to hold a class