Failure Mode and Effects Analysis (FMEA)

Introductory Overview

TARDEC Systems Engineering Risk Management Team

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**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.**
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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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 (FMEA) can have SIGNIFICANT impact on Life Cycle Costs!

RED = no FMEA
GREEN = FMEA proactively done

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.
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!!
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.

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
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

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!!
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:

1. Load ink tube vertically into fixture
   - Inputs: Fixture, Ink Tube, Operator
   - Output: Tube aligned for spring insertion

2. Load spring into press
   - Inputs: Press, Spring, Operator
   - Output: Spring aligned for insertion

3. Press spring on to tube
   - Inputs: Fixture, Spring, Tube, Press, Operator
   - Output: Completed ink/spring ass’y
## 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!

The table below shows the Process PFMEA.

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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.....
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Unclassified
# How does FMEA work?

--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
1 | Load ink tube vertically into fixture | Tube mis-aligned | Spring cannot be inserted | 5 | Fixure features/dimensions incorrect | Fixture drawings | 3 | Go/No Go Guage | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
1 | Load ink tube vertically into fixture | Tube mis-aligned | Spring cannot be inserted | 6 | Operator not trained | Work instructions | 5 | Visual inspection | 7 | 175 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
1 | Load ink tube vertically into fixture | Tube missing | Spring cannot be inserted | 5 | Fixure features/dimensions incorrect (tube fell out) | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
1 | Load ink tube vertically into fixture | Tube missing | Spring cannot be inserted | 6 | Operator forgot to load tube | Visual inspection | 6 | No detection control | 10 | 300 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
2 | Load spring into press | Spring mis-aligned | Spring cannot be inserted | 5 | Fixure features/dimensions incorrect | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
2 | Load spring into press | Spring mis-aligned | Spring cannot be inserted | 6 | Operator not trained | Work instructions | 5 | Visual inspection | 7 | 175 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
2 | Load spring into press | Spring missing | Spring cannot be inserted | 5 | Fixure features/dimensions incorrect (spring fell out) | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
2 | Load spring into press | Spring missing | Spring cannot be inserted | 6 | Operator forgot to load tube | Visual inspection | 6 | No detection control | 10 | 300 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
2 | Load spring into press | Spring missing | Spring cannot be inserted | 5 | Fixure features/dimensions incorrect | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
3 | Press spring on to tube | Spring not fully pressed on to tube | Spring mis-aligned | 2 | Fixure features/dimensions incorrect | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
3 | Press spring on to tube | Spring not fully pressed on to tube | Spring mis-aligned | 2 | Fixure features/dimensions incorrect | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
3 | Press spring on to tube | Spring not on tube too far | Spring mis-aligned | 2 | Fixure features/dimensions incorrect | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
3 | Press spring on to tube | Spring not on tube at all | Spring mis-aligned | 2 | Fixure features/dimensions incorrect | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
3 | Press spring on to tube | Spring pressed on incorrectly | Spring mis-aligned | 2 | Fixure features/dimensions incorrect | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22
3 | Press spring on to tube | Spring pressed on incorrectly (crushed) | Spring mis-aligned | 2 | Fixure features/dimensions incorrect | Fixture drawings | 3 | In line sensor | 2 | 30 | Install sensor to detect tube | G. Ratapczak | Sensor installed at ST001 | 5 | 6 | 2 | 22

---

## Potential Causes / Mechanisms of Failure

<table>
<thead>
<tr>
<th>Failure</th>
<th>Potential Causes / Mechanisms of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure 1</td>
<td>Fixure features/dimensions incorrect</td>
</tr>
<tr>
<td>Failure 2</td>
<td>Fixure drawings</td>
</tr>
</tbody>
</table>

---

## Unclassified
### FMEA Process

#### Process Step 1: Load Ink Tube Vertically Into Fixture
- **Potential Failure Mode:** Tube mis-aligned
- **Potential Effects of Failure:** Spring cannot be inserted
- **Severity:** 5
- **Classification:** Potential causes/mechanisms of failure: Fixture features/dimensions incorrect
- **Current Process Controls Prevention:** None
- **Occurrence:** Fixture drawings
- **R.P.A.:** Go/No Go Guage
- **Action Results:**
  - **Recommended Actions:** Install sensor to detect tube
  - **Responsibility & Target Completion Date:** G. Ratajczak 07/MAR/2012
  - **Action Taken:** Sensor installed at ST001

#### Process Step 2: Load Spring into Press
- **Potential Failure Mode:** Spring mis-aligned
- **Potential Effects of Failure:** Spring cannot be inserted
- **Severity:** 5
- **Classification:** Potential causes/mechanisms of failure: Fixture features/dimensions incorrect (tube fall off)
- **Current Process Controls Prevention:** None
- **Occurrence:** Fixture drawings
- **R.P.A.:** Go/No Go Guage
- **Action Results:**
  - **Recommended Actions:** Install sensor to detect spring
  - **Responsibility & Target Completion Date:** G. Ratajczak 07/MAR/2012
  - **Action Taken:** Sensor installed at ST002

#### Process Step 3: Press Spring on to Tube
- **Potential Failure Mode:** Spring not fully pressed on to tube
- **Potential Effects of Failure:** Spring may fall off in a later step
- **Severity:** 5
- **Classification:** Potential causes/mechanisms of failure: Inktube may not retract/extend
- **Current Process Controls Prevention:** None
- **Occurrence:** Inktube may not retract/extend
- **R.P.A.:** Go/No Go Guage
- **Action Results:**
  - **Recommended Actions:** Install position sensor at full travel
  - **Responsibility & Target Completion Date:** G. Ratajczak 07/MAR/2012
  - **Action Taken:** Sensor installed at ST003

#### Current Process Controls Detection

- **Detect:** Go/No Go Guage
- **Severity:** 2

---

### Current Process Controls Detection

#### Go/No Go Guage

- **Severity:** 2

---

### Unclassified

[Diagram of detection process]
### How does FMEA work?

<table>
<thead>
<tr>
<th>Process step #</th>
<th>Process step function / requirements</th>
<th>Potential Failure Mode</th>
<th>Potential Effects of Failure</th>
<th>Severity</th>
<th>Classification</th>
<th>Potential Causes / Mechanisms of Failure</th>
<th>Current Process Controls Prevention</th>
<th>Score</th>
<th>Recommended Actions</th>
<th>RPN</th>
<th>Responsibility &amp; Target Completion Date</th>
<th>Action Results</th>
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<tr>
<td>1</td>
<td>Load ink tube vertically into fixture</td>
<td>Tube mis-aligned</td>
<td>Spring cannot be inserted</td>
<td>5</td>
<td>3 x 2 x 1 = 6</td>
<td>Fixture features/dimensions incorrect</td>
<td>Fixture drawings</td>
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<td>2  30</td>
<td>Install sensor to detect tube</td>
<td>5  6  2  22</td>
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<tr>
<td>2</td>
<td>Load ink tube vertically into fixture</td>
<td>Tube missing</td>
<td>Spring cannot be inserted</td>
<td>5</td>
<td>3 x 2 x 1 = 6</td>
<td>Fixture features/dimensions incorrect</td>
<td>Fixture drawings</td>
<td>3  In line sensor</td>
<td>2  30</td>
<td>Sensor installed at ST01</td>
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</tr>
<tr>
<td>3</td>
<td>Load ink tube vertically into fixture</td>
<td>Tube missing</td>
<td>Spring cannot be inserted</td>
<td>5</td>
<td>3 x 2 x 1 = 6</td>
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<td>Fixture drawings</td>
<td>3  In line sensor</td>
<td>2  30</td>
<td>Sensor installed at ST02</td>
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<tr>
<td></td>
<td>Press spring on to tube</td>
<td>Spring mis-aligned</td>
<td>Spring may fall off in a later step</td>
<td>7</td>
<td>3 x 2 x 1 = 6</td>
<td>Press does not move far enough down</td>
<td>Position sensors</td>
<td>1  Visual inspection</td>
<td>8  30</td>
<td>Sensor installed at ST03</td>
<td>7  6  2  22</td>
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<td>7</td>
<td>3 x 2 x 1 = 6</td>
<td>Press does not move far enough down</td>
<td>Position sensors</td>
<td>1  Visual inspection</td>
<td>8  30</td>
<td>Sensor installed at ST04</td>
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<tr>
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<td>Press spring on to tube</td>
<td>Spring pressed on to tube too far</td>
<td>Spring may fall off in a later step</td>
<td>7</td>
<td>3 x 2 x 1 = 6</td>
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<td>1  Visual inspection</td>
<td>8  30</td>
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<tr>
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<td>Press spring on to tube</td>
<td>Spring not on tube at all</td>
<td>Spring may fall off in a later step</td>
<td>7</td>
<td>3 x 2 x 1 = 6</td>
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<td>Position sensors</td>
<td>1  Visual inspection</td>
<td>8  30</td>
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<td>7  6  2  22</td>
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<td></td>
<td>Press spring on to tube</td>
<td>Spring moved on incorrectly</td>
<td>Spring may fall off in a later step</td>
<td>7</td>
<td>3 x 2 x 1 = 6</td>
<td>Press does not move far enough down</td>
<td>Position sensors</td>
<td>1  Visual inspection</td>
<td>8  30</td>
<td>Sensor installed at ST07</td>
<td>7  6  2  22</td>
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<td>Spring may fall off in a later step</td>
<td>7</td>
<td>3 x 2 x 1 = 6</td>
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<td>1  Visual inspection</td>
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<td>3 x 2 x 1 = 6</td>
<td>Press does not move far enough down</td>
<td>Position sensors</td>
<td>1  Visual inspection</td>
<td>8  30</td>
<td>Sensor installed at ST09</td>
<td>7  6  2  22</td>
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</table>

**Risk Priority Number (RPN)**

RPN = \(5 \times 3 \times 2 = 30\)

Out of a possible \(10 \times 10 \times 10 = 1000\)

This risk ranks relatively low....
How does FMEA work?

<table>
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<tbody>
<tr>
<td>1</td>
<td>Load ink tube vertically into fixture</td>
<td>Tube misaligned</td>
<td>Spring cannot be inserted</td>
<td>5</td>
<td></td>
<td>Fixture features/dimensions incorrect</td>
<td>Fixture drawings</td>
<td>3</td>
<td>Go/No Go Gauge</td>
<td>2</td>
<td>30</td>
<td>Install sensor to detect tube</td>
<td>G. Ratyczak 07/MAR/2012 Sensor installed at ST091</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>22</td>
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<td>Fixture features/dimensions incorrect</td>
<td>Fixture drawings</td>
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<td>In line sensor</td>
<td>2</td>
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<td>Install sensor to detect tube</td>
<td>G. Ratyczak 07/MAR/2012 Sensor installed at ST091</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>22</td>
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<td>In line sensor</td>
<td>2</td>
<td>30</td>
<td>Install sensor to detect tube</td>
<td>G. Ratyczak 07/MAR/2012 Sensor installed at ST091</td>
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<td>6</td>
<td>2</td>
<td>22</td>
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<td>In line sensor</td>
<td>2</td>
<td>30</td>
<td>Install sensor to detect tube</td>
<td>G. Ratyczak 07/MAR/2012 Sensor installed at ST091</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>22</td>
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</tbody>
</table>

**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

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<td>1</td>
<td>Load ink tube vertically into fixture</td>
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<td>Spring cannot be inserted</td>
<td>5</td>
<td>Fixtures/features/dimensions</td>
<td>Fixture drawings</td>
<td>2 Go/No Go Gauge</td>
<td>2</td>
<td></td>
<td>30</td>
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<td>Fixtures/features/dimensions</td>
<td>Fixture drawings</td>
<td>2 Go/No Go Gauge</td>
<td>2</td>
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<td>Spring cannot be inserted</td>
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<td>Fixtures/features/dimensions</td>
<td>Fixture drawings</td>
<td>2 Go/No Go Gauge</td>
<td>2</td>
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<td>30</td>
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<td>Spring cannot be inserted</td>
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<td>Fixtures/features/dimensions</td>
<td>Fixture drawings</td>
<td>2 Go/No Go Gauge</td>
<td>2</td>
<td></td>
<td>30</td>
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</table>

#### Recommended Actions

- **Install position sensor at full travel**
- **Date of Action:** 07/MAR/2012
- **Location:** Sensor installed at ST003

#### Action Results

<table>
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<tr>
<th>Actions Taken</th>
<th>Severity</th>
<th>Occur</th>
<th>Detection</th>
<th>R.P.N.</th>
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<tr>
<td>Sensor installed at ST003</td>
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<td>6</td>
<td>2</td>
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<tr>
<td>G. Ratajczak</td>
<td>07/MAR/2012</td>
<td>5</td>
<td>6</td>
<td>22</td>
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</tbody>
</table>

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**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.

*Unclassified*
Take action where needed  
Sorting by RPN

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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Load ink tube vertically into fixture</td>
<td>Tube missing</td>
<td>Spring cannot be inserted</td>
<td>5</td>
<td>Operator forgot to load tube</td>
<td>10 300</td>
</tr>
<tr>
<td>2</td>
<td>Load spring into press</td>
<td>Spring missing</td>
<td>Spring cannot be inserted</td>
<td>5</td>
<td>Operator forgot to load spring</td>
<td>10 300</td>
</tr>
<tr>
<td>4</td>
<td>Load plunger ass'y to fixture</td>
<td>Plunger ass'y missing</td>
<td>Housing cannot be added</td>
<td>5</td>
<td>Operator forgot to load plunger ass'y</td>
<td>10 300</td>
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<tr>
<td>5</td>
<td>Load barrel on to press</td>
<td>Barrel mis-aligned</td>
<td>Housing cannot be added</td>
<td>5</td>
<td>Operator forgot to load barrel</td>
<td>10 300</td>
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<tr>
<td>3</td>
<td>Press spring on to tube</td>
<td>Spring not on tube at all</td>
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<td>Spring fell off of press while moving downward</td>
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<td>Housing cannot be added</td>
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<td>Operator not trained</td>
<td>10 200</td>
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<td>5</td>
<td>Load barrel on to press</td>
<td>Barrel mis-aligned</td>
<td>Housing cannot be added</td>
<td>5</td>
<td>Operator not trained</td>
<td>10 200</td>
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<td>1</td>
<td>Load ink tube vertically into fixture</td>
<td>Tube mis-aligned</td>
<td>Spring cannot be inserted</td>
<td>5</td>
<td>Operator not trained</td>
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<tr>
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<td>Load spring into press</td>
<td>Spring mis-aligned</td>
<td>Spring cannot be inserted</td>
<td>5</td>
<td>Operator not trained</td>
<td>7 175</td>
</tr>
<tr>
<td>3</td>
<td>Press spring on to tube</td>
<td>Spring pressed on incorrectly</td>
<td>Ink/tube may not retract/extend</td>
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<td>KPP</td>
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<td>6</td>
<td>Press barrel on to plunger</td>
<td>Barrel pressed on incorrectly</td>
<td>Damaged parts/Scrap</td>
<td>8</td>
<td>Verify alignment at each shift</td>
<td>96</td>
</tr>
</tbody>
</table>

Unclassified
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.
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.
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!

**Pareto chart of RPN by cause group**

This group represents all causes that have anything to do with operators (poor part placement, activation of the press, lack of training, etc).
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.
In the event that a failure mode is encountered, the FMEA can be the first source for reactive problem solving.

1. **Is the failure mode or its effect listed on either FMEA?**
   - **YES:** Control has failed - find out why, improve control, update FMEA.
   - **NO:** Root cause is not on FMEA. Use other methods to identify root cause. Recalculate RPN and update FMEA.

2. **Is the root cause listed on the FMEA?**
   - **YES:** Control has failed - find out why, improve control, update FMEA.
   - **NO:** Root cause is not on FMEA. Use other methods to identify root cause. Recalculate RPN and update 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.
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?**
UPCOMING 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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Need minimum of 15 enrolled to hold a class