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**Failure Mode and Effects Analysis (FMEA)**

“The major difference between a thing that might go wrong and a thing that cannot possibly go wrong is that when a thing that cannot possibly go wrong goes wrong it usually turns out to be impossible to get at or repair.”  
-Douglas Adams

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### Failures and Risks Within the Process

- What will stop the process?
- What will affect the citizen the most?
- What will prevent delivery?
- What will really slow things down?
- What will add great complication?
- What would be catastrophic?

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### Looking for Failure or Risk

- Look ahead
- Plan for problems
- Contingencies
- “Go – No Go” on a project
- Modifications in scope
- Awareness of mandates and/or laws
- Understanding our reach or control

*Government work has many people to keep happy!! – What will be the impact on every one?*

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### Failure Quotes

- *“The greatest barrier to success is the fear of failure.”*
- *“The only real failure in life is the failure to try.”*
- *“Fear of failure must never be a reason not to try something.”*
- *“Action conquers fear.”*
- *“Believe and act as if it were impossible to fail.”*
- *“An inventor fails 999 times, and if he succeeds once, he's in. He treats his failures simply as practice shots.”*

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## Are We Afraid to Make Changes?

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### Reality

- Be prepared/ready for when things fail
  - Analyze the problem
  - Study the process
  - Thoughtfully make changes
  - Introduce new ways
- When introducing a new process
  - Analyze what could go wrong
  - Study how it will impact things
  - Proactively reveal in advance the potential outcomes

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### What Could Fail in State Government?

• Leadership Change	• Printer/Scanner failure
• Funding Cut Off	• Wrong document(s)
• Changes in Staff	• Lost document(s)
• Citizen Complaints	• Dropped calls
• Legislator Complaint	• Call Transfers
• Lack of Skills/Training	• Fee revenue losses
• Lack of IT Support	• Delays to citizen
• Lack of Resources	• Purchase delay
• Geography Problems	• Payment delay
• Poor Planning and Follow-up	• Data entered incorrectly
• Poor Control or Measurement	• Customer error
• Computer failure	• Non-standard procedure

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## People Issues - Real Examples

- “They won’t let us do that...”
- “That’s impossible...”
- “The law says that...”
- “We have always done it this way...”
- “There is no way that...”
- “Citizens will go crazy....”
- “They’ll call the Governor...”
- “It can’t be done that way...”

**Assumptions**

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## FMEA Allows Us To...

- Do your preemptive work
- Determine where to focus time and resources
- Brainstorm how to prioritize issues affecting the project
- Understand where and when to take “special care”



**Proactive**

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## NASA Example January 28, 1986

### ANATOMY OF O-RING

- 1** If the initial squeeze is too tight, pressure from hot gases cannot push the O-ring into gap. As a result, its ability to seal the gap is inhibited.
- 2** When engine fires, joint gap widens. However, if O-ring is too cold, its resiliency is reduced and it cannot spring back fast enough to seal gap.
- 3** Correct compression leaves enough space for pressure to get behind the entire face of O-ring and force it into the gap between sections.

### FATAL LEAK

After the solid fuel boosters ignited, photos revealed a puff of dark smoke swirling between the right hand booster and the external fuel tank. This is the location of the seal that burned through about 70 seconds later and caused shuttle to explode.

Pressure from super-heated gases in fuel core

Super-heated gases burn past O-rings and escape out joint.

The initial leak could have been resealed by debris, but flight stresses caused gap to open again.

**SRB "O" rings had very high RPN**

Smoke

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**Control and Cost**

1. Prevention \$
2. Detection \$\$
3. Correction \$\$\$\$

– Exponentially expensive

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**Failure Mode and Effect Analysis (FMEA)**

Start by listing ways the project might potentially fail (Problem)

- Evaluate the severity (S) of each problem
  - “1” represents failure with no effect and “10” represents very severe and catastrophic failure
- Estimate the likelihood (L) of each problem occurring
  - “1” indicates that failure is rather remote and not likely to occur and “10” indicates that failure is almost certain to occur

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**FMEA**

- Estimate ability to detect each problem (D)
  - “1” is used when monitoring and control systems are almost certain to detect the failure and “10” where it is virtually certain the failure will not be detected
- Next calculate the Risk Priority Number (RPN)
  - Multiply S, L and D together
- Sort potential failures by their RPNs and focus on the highest RPNs
- Finally, consider ways of reducing the risk associated with failures with high RPNs

**Severity x Likelihood x Detectability = RPN**

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### Sample Rating Scale

Rating	Severity of Effect	Likelihood of Occurrence	Ability to Detect
10	Catastrophic	Very high: Failure is almost inevitable	Can not detect
9	Very Severe		Very remote chance of detection
8	Severe	High: Repeated failures	Remote chance of detection
7	Moderately severe		Very low chance of detection
6	Loss of functionality	Moderate: Occasional failures	Low chance of detection
5	Significant effect		Moderate chance of detection
4	Obvious effect		Moderately high chance of detection
3	Noticeable effect	Low: Relatively few failures	High chance of detection
2	Minor effect		Very high chance of detection
1	No effect		Remote: Failure is unlikely

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### Failure Mode and Effect Analysis (FMEA)

Cross Country RV Trip

*Example*

Problem	Severity	Likelihood	Detection	RPN score
Run out Gas	1	3	2	6
<b>Flat Tire</b>				
Dead Battery	2	4	5	40
Blow tire	8	4	8	256
Engine problem	5	4	7	140
<b>Engine Blowup</b>				

**Severity X Likelihood X Detection = RPN**

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### Application

- Citizen needs permit
- Citizen gets form from web
- Citizen completes form
- Citizen submits form
- Citizen submits fee
- Department receives form
- Department receives fee
- Department analyzes form
- Department issues permit

1. What could fail
2. What usually fails
3. What is the severity
4. What is the likelihood
5. Will we detect it or have too Correct it

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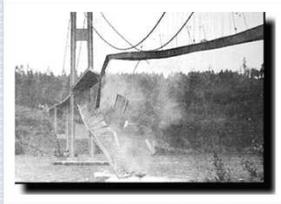
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## Flexibility

- Build in safeguards
- Think of contingencies
- Course corrections should be expected
- Make "Fail Safe" when possible



[https://www.youtube.com/watch?v=yj\\_R4oCTPI](https://www.youtube.com/watch?v=yj_R4oCTPI)

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## Now What?

- Focus on High RPNs
- Look for causes
- First-find **prevention**
- Secondly-examine detectability
- Third-consider correction
- Any new processes should consider FMEA  
Monitors, Measures, Poka Yoke, Control

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## Key Learning Points

The Green Belt should now be able to:

- Have a working knowledge risk management
- Create an FMEA analysis to help determine high risk problem areas
- Understand the importance of detection and working to find solutions to solve problems

**Questions?**

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