Failure Mode and Effect Analysis

Lecture 2-1
Cause-Effect Tools

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FMEA

Cause-Effect Analysis

Cause-Effect Principle
Cause-Effect Model
Root Cause Analysis
Problem Solving

• Typical problem-solving practices
  – Stopping too soon
  – The need to place blame
  – Root cause myth
  – Illusion of common sense and a single reality
  – Storytelling
  – Categorical thinking

Reference: Apollo Root Cause Analysis, Dean L. Gano

Causes if Ineffective Problem Solving

• Incomplete problem definition
• Unknown causal relationships
• Focus on solutions

Reference: Apollo Root Cause Analysis, Dean L. Gano
**Cause-Effect Principle**

1. **Cause and Effect are the same thing**

<table>
<thead>
<tr>
<th>EFFECTS</th>
<th>CAUSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury</td>
<td>caused by</td>
</tr>
<tr>
<td>Fall</td>
<td>caused by</td>
</tr>
<tr>
<td>Wet Surface</td>
<td>caused by</td>
</tr>
<tr>
<td>Leaky Valve</td>
<td>caused by</td>
</tr>
<tr>
<td>Seal failure</td>
<td>caused by</td>
</tr>
</tbody>
</table>

Reference: *Apollo Root Cause Analysis*, Dean L. Gano

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2. **Causes and effects are part of an infinite continuum of causes**

Reference: *Apollo Root Cause Analysis*, Dean L. Gano
3. Each effect has at least 2 causes in the form of actions and conditions

Why?

Primary Effect
   Action Cause
   Condition Cause

Reference: *Apollo Root Cause Analysis*, Dean L. Gano

4. An effect exists only if its causes exist at the same point in time and space

Action
   effect
   condition
   condition
   condition

Reference: *Apollo Root Cause Analysis*, Dean L. Gano
Cause-Effect Model

Initial Problem
1st “Why”

FMEA

Cause becomes new problem

POTENTIAL PROBLEM

LIKELY CAUSES

LIKELY EFFECTS

TRIGGER

PREVENTIVE ACTIONS

CONTINGENT
- ADAPTIVE
- CORRECTIVE

GET GLASSES

WEAR HELMET

REMOVE DOORS

Problem becomes effect

BUMP HEAD

WALK INTO DOOR

PAIN

NEAR-SIGHTED

POTENTIAL PROBLEM

LIKELY CAUSES

LIKELY EFFECTS

TRIGGER

PAIN

PREVENTIVE ACTIONS

CONTINGENT
- ADAPTIVE
- CORRECTIVE

SURGERY

REMOVE DOORS

GET GLASSES
2nd “Why”

FMEA

POTENTIAL PROBLEM

NEAR-SIGHTED

LIKELY CAUSES

LIKELY EFFECTS

TRIGGER

PAIN

PREVENTIVE

ACTIONS

CONTINGENT

- ADAPTIVE

- CORRECTIVE

SURGERY

REMOVE DOORS

GET GLASSES

BUMP HEAD

WALK INTO DOOR

CAN’T SEE

CAN’T SEE

FAIL EYE TEST

PREVENTIVE

ACTIONS

CONTINGENT

- ADAPTIVE

- CORRECTIVE

CUT OUT STAR TREK

GET GLASSES

REMOVE DOORS

HAVE WE FOUND ROOT CAUSE?
Breaking the Cause-Effect Chain  

**FMEA**

HAVE WE FOUND ROOT CAUSE?

**Potential Failure Mode**

<table>
<thead>
<tr>
<th>Cause</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too Much T.V.</td>
<td></td>
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<tr>
<td>Likely Causes</td>
<td></td>
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<tr>
<td>Likely Effects</td>
<td></td>
</tr>
<tr>
<td>Near-Sighted</td>
<td></td>
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<tr>
<td>Can’t See</td>
<td></td>
</tr>
<tr>
<td>Walk Into Door</td>
<td></td>
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<tr>
<td>Bump Head</td>
<td></td>
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<tr>
<td>Preventive Actions</td>
<td></td>
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<tr>
<td>Contingent Actions</td>
<td></td>
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<tr>
<td>Adaptive</td>
<td></td>
</tr>
<tr>
<td>Corrective</td>
<td></td>
</tr>
<tr>
<td>Cut Out Star Trek</td>
<td></td>
</tr>
<tr>
<td>Get Glasses</td>
<td></td>
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<tr>
<td>Remove Doors</td>
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Million Dollar Question?

At what point is the cause-effect chain sufficiently “broken?”

How Far Do You Go?

Potential Failure Mode → Observed Effect

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<th>Why?</th>
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Root Cause Analysis

Cause-Effect is based on the idea that we can positively identify what we don’t like about a situation and trace it back to some underlying cause or causes.

Effects can be . . . .

– Desirable
– Undesirable . . . . but they can only be categorized by comparing them to some designated standard

The Cause-Effect tree is a very effective tool for a team to use to assess and trace a problem to root cause. It is particularly effective with complex problems which have several effects and potential causes.

What is a Root Cause?

• Lowest point in a cause – effect chain at which we have capability to cause a break.
• It is the lowest point at which human interaction can break the cause-effect chain
Root Cause Analysis Method  

- Once the problem or situation is defined, brainstorm the effect
- From each effect, ask “Why” and continue until root cause is reached.

Products are failing for contamination

**WHY?** Containers leak at mounting screw hole

**WHY?** Suppliers leak test may not detect porosity leak

**WHY?** Suppliers have different leak test processes

**WHY?** No standard process for supplier leak test

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Root Cause Analysis Method - Steps  

1. Identify Span of control and Sphere of Influence
2. Create a List of Undesirable Effects (UDE’s)
   
   Undesirable effects are negative by their own merit
3. Write the UDE’s on to Post-it™ Notes and place on a large sheet of paper
### Undesirable Effect (UDE)  
**FMEA**

- Really Exists
- Negative on its own merits

<table>
<thead>
<tr>
<th>Undesirable on their own merits</th>
<th>Neutral or marginal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers are Laid Off</td>
<td>Absenteeism is rising</td>
</tr>
<tr>
<td>Net Profit is decreasing</td>
<td>Engineering and Production can’t agree</td>
</tr>
<tr>
<td>My boss is angry with me</td>
<td>I am late for work</td>
</tr>
</tbody>
</table>

**UDE or “fact of life?”**

### Correlation vs Cause-Effect  
**FMEA**

- Cause-Effect diagram must not contain hidden correlations
- What is the difference between Cause-Effect and Correlation?
- How can “chasing correlations” lead you astray in a Cause-Effect analysis?
4. Connect UDE’s if one leads to, but not necessarily causes, the other. Lower UDE is the leader, upper is the follower. 
*Test with IF - THEN*

5. Determine if any steps are missing between the leader and the follower or if other contributing causes exist. Fill them in. Use ellipses to represent AND situations.

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6. Connect other UDE’s and build Cause-Effect chain downward from each. Continue adding missing steps and contributing causes.
7. Add or redesignate UDE’s. Do the originals still qualify in the context of the rest of the diagram?

8. Identify Root Causes and Core Problems (Root causes are boxes with arrows coming out but none going in).

9. Look for common connections to the various branches. These root causes could represent “deep fixes”.

10. Determine causes which are within the Span of Control and the Sphere of Influence for the Black Belt Team.