

DRIVEN BY VALUE



# Root Cause Analysis: Mining for Answers/Delivering Prevention

Rob Stepp, CIH, CSP, ARM, REHS

Department of Occupational Safety & Health

October 13, 2017



# Objectives

- What is Root Cause Analysis (RCA)
- Why Use It
- What Drivers Influence Doing RCA
- What is the Objective
- Understanding Cause vs Correlation
- Methods
- Resources
- Delivering Prevention

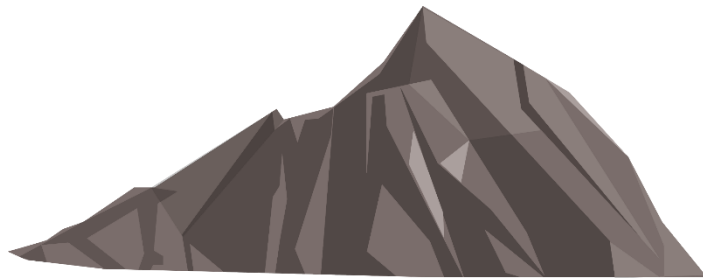


# What is Root Cause Analysis (RCA)

- RCA is a process used to uncover various contributing factors that led to an incident or non-conformance that resulted in a fatality or serious injury/illness (not appropriate for near miss events).
- A RCA considers the contribution of individual elements that additively (or multiplicatively) result in an undesired outcome and includes the influence of factors such as:
  - Leadership/supervision
  - Communication
  - Training
  - Distraction
  - Experience
  - Fatigue
  - Proper tools
  - Design



# Why Use Root Cause Analysis



www.getty.com - HPCBBR



# Why Use Root Cause Analysis

- A typical ore body has a copper content of 0.1% to 1.5+%—mining and processing transform that to 99+% pure copper by continuously removing the unwanted “overburden” of less desirable material (or focuses on the desirable material).
- An effective RCA considers the relevant details relating to causes, and concentrates and refines the information to arrive at the root causes. Any flaw or error may have relevance—the objective is to focus on the relevant factors, that if corrected or eliminated, would have prevented the incident from happening.
- Root causes become the focus of actions and measures taken to prevent repetition and/or minimize the severity of an incident.



# Why Use Root Cause Analysis

Lagging indicators have failed to be reliable predictors of outcome



Compiled from data on U.S. Mine Safety and Health Administration website: [www.msha.gov/data-reports/statistics](http://www.msha.gov/data-reports/statistics), accessed 9/13/2016.



Heinrich's Pyramid



# Drivers: Why You Should Care

- The Arizona Mining Association (AMA) member companies are committed to an injury free workplace. The AMA insists upon health and safety of employees as a common value for member companies.
- The AMA recognizes member companies may have differing safety programs in place at the respective operations. However, the goal of each of these programs is the same: *Protect and enhance the health and safety of all employees.*



# Drivers: Why You Should Care

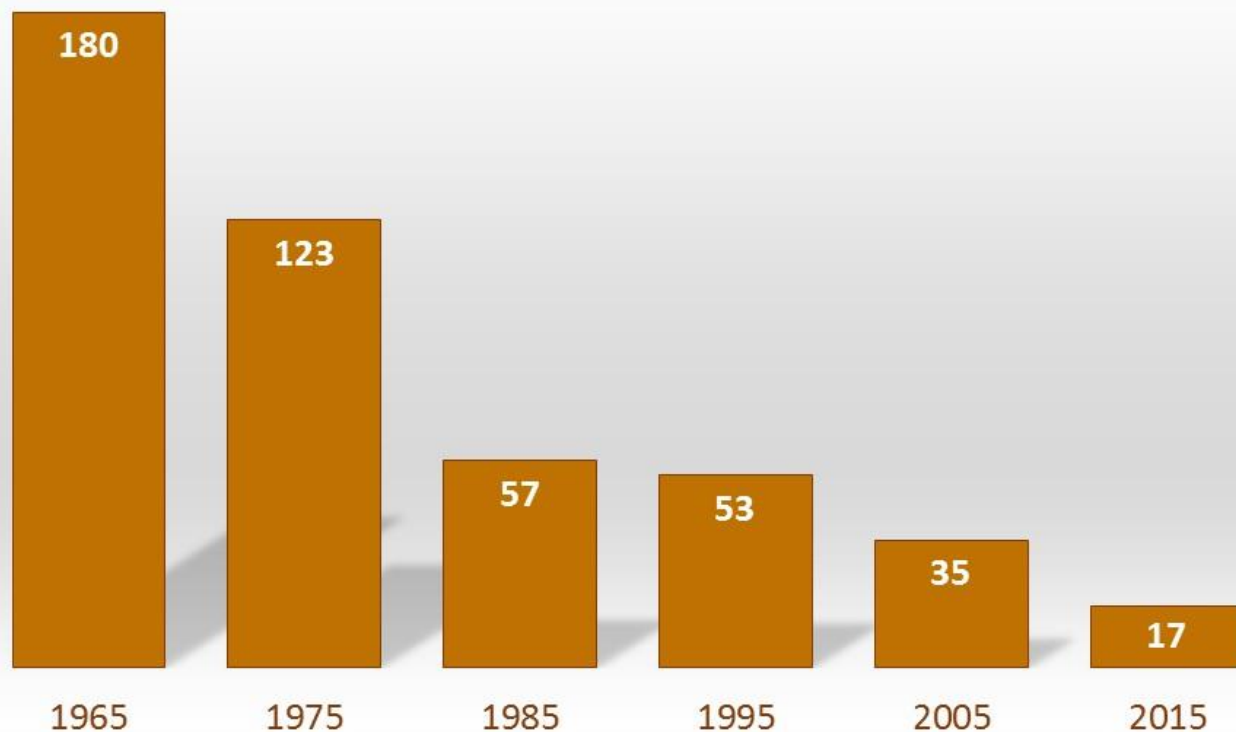


Data compiled by National Mining Association using 2015 statistics from on U.S. Mine Safety and Health Administration, <http://www.nma.org/index.php/safety-statistics>



# Drivers: Why You Should Care

Fatalities in Metal/Non-Metal U.S. Mines, 1965-2015

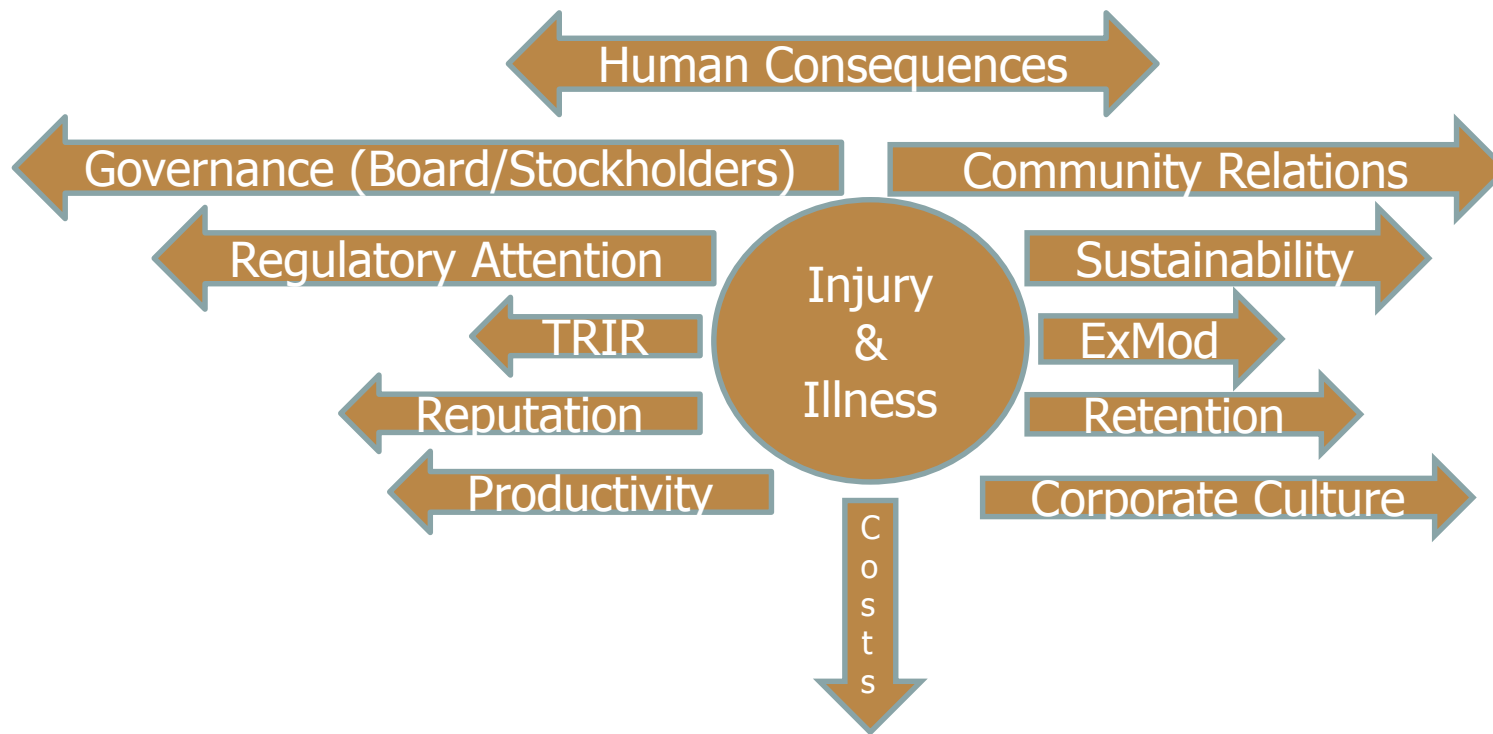


Compiled from data on U.S. Mine Safety and Health Administration  
website: [www.msha.gov/data-reports/statistics](http://www.msha.gov/data-reports/statistics), accessed 9/13/2016.



# Drivers: Why You Should Care

Aside from trade association or organizational commitments and reductions over time, other compelling reasons exist to prevent injury/illness in the work place:





## Decision Time: What is the objective?

To effectively prevent injury and illness, the objective needs to be clear and unambiguous. The choices are to:

Determine the cause(s) and influencing factor(s) to be corrected or eliminated with the outcome of ultimately preventing or substantially reducing severity

OR

Assign blame/fault, not proactively recognizing and correcting the problem(s)—with the certainty that the incident will reoccur?



# Correlation vs Cause

Don't forget or misunderstand the objective – **Causation**

- Causation is an occurrence or action that can cause another occurrence/action
- With Causation, the results are predictable and certain





# Methods

A number of methods have been developed, or adapted to conduct a RCA:

- Fishbone Analysis (Ishikawa Root Cause Analysis)
  - Fault Tree Analysis
  - Failure Modes and Effect Analysis
  - Storytelling
  - Pareto Analysis
  - Why-Why Chart/The Five Whys
  - Bowtie
  - RealityCharting®
- No silver bullet, no perfect method. All require effort and time; all require follow-up; all require the commitment to proactively prevent injury and illness from occurring.
  - Best results may come from combining methods and techniques.
  - Every incident is unique and is the result of multiple contributory factors.



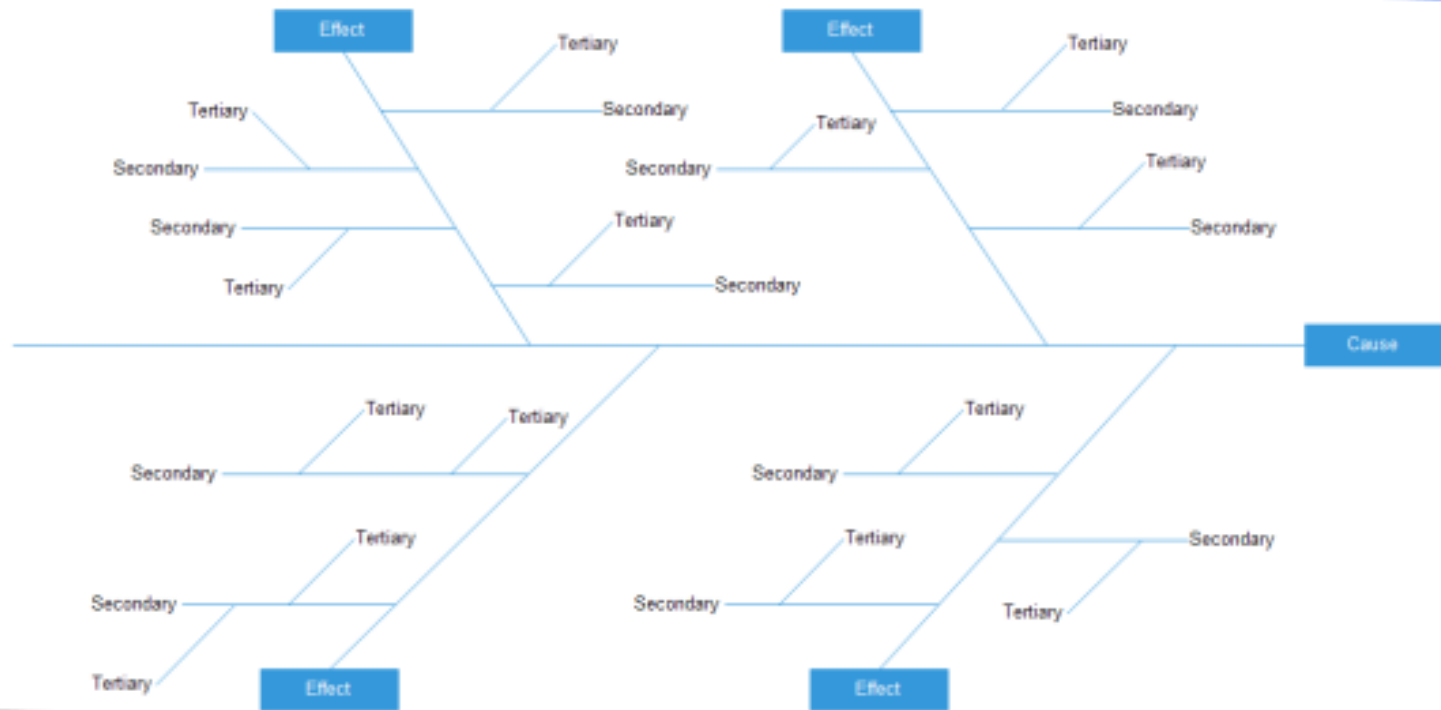
# Method—Fishbone (Ishikawa RCA)

- Well known
- Useful when the results are needed quickly
- Works well with a large group of participants
- The question involves a single, well defined problem which is defined at the “head” of the fish
- Requires good upfront preparation and can involve utilization of the FMEA, HazOps, or other process-relevant methods that identify vulnerabilities (and corresponding controls)
- Focus areas, which can be further sub-categorized, include:
  - Manpower
  - Methods
  - Machinery
  - Environment



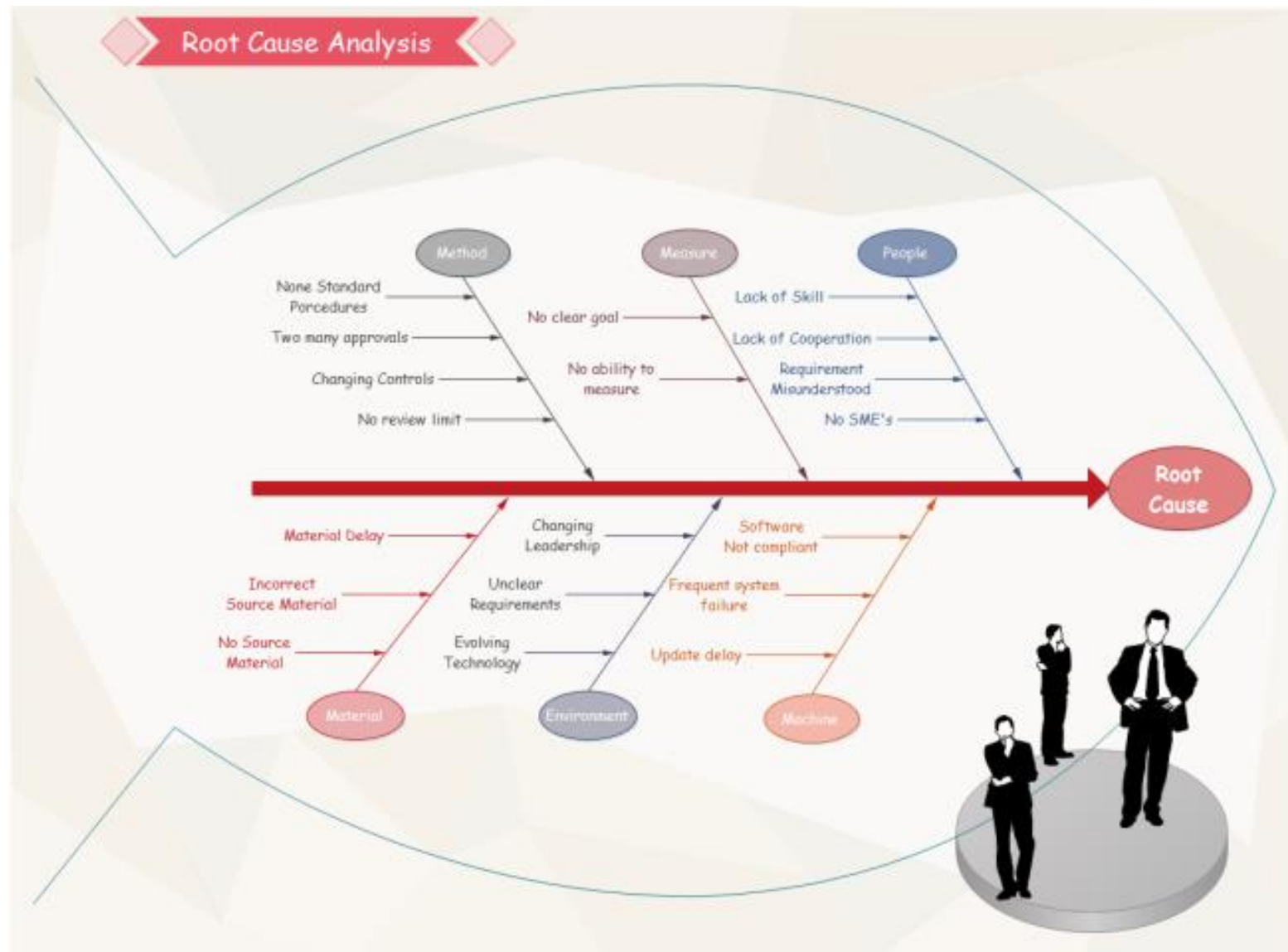
# Method–Fishbone

## Cause-Effect (Fishbone) Diagram





# Methods–Fishbone



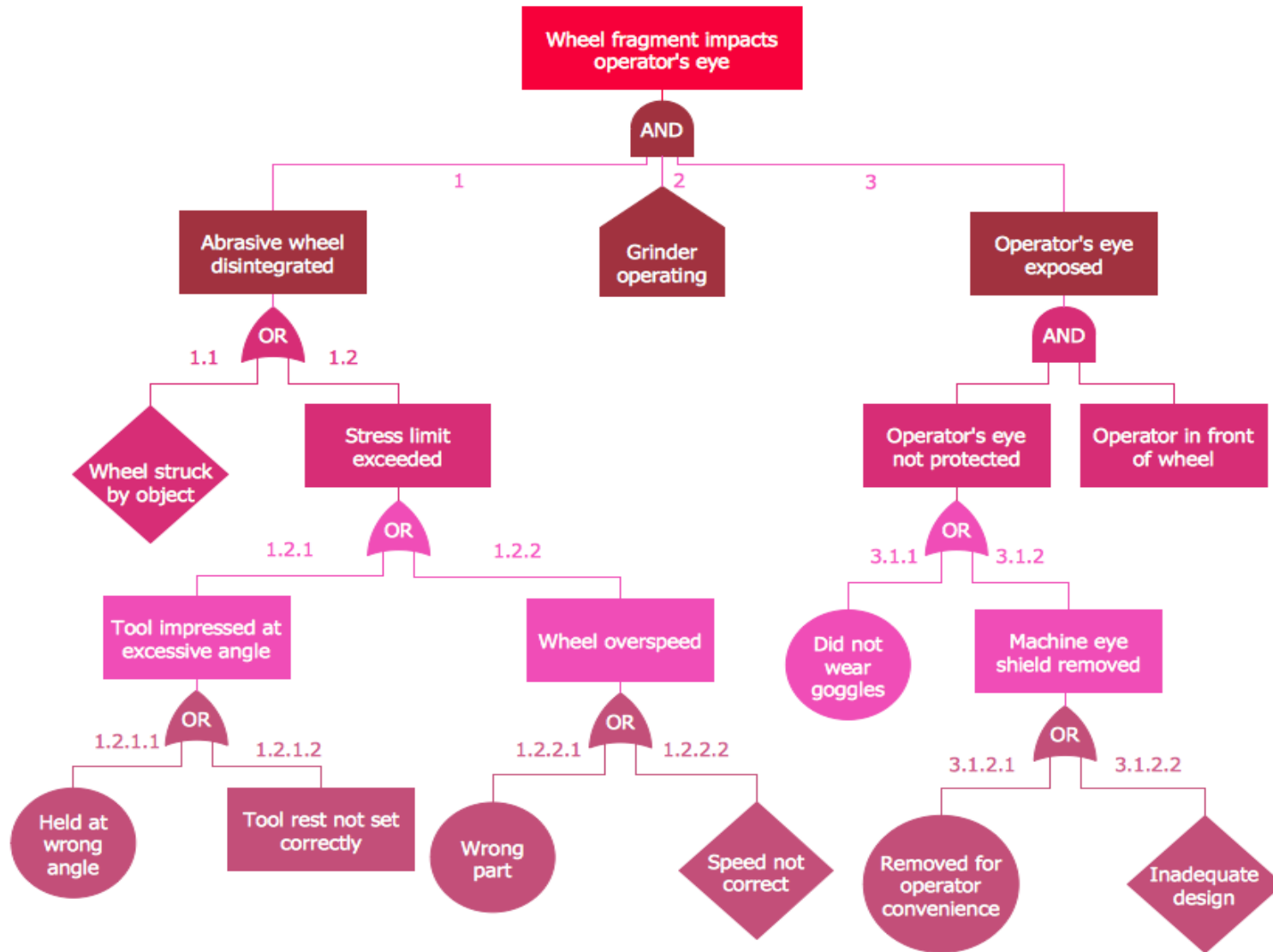


# Methods—Fault Tree Analysis

- First introduced by Bell Laboratories
- Is one of the most widely used methods in system reliability, maintainability and safety analysis
- It is a deductive procedure used to determine the various combinations of hardware and software failures and human errors that could cause undesired events (referred to as top events) at the system level
- Begins with a general conclusion, then attempts to determine the specific causes of the conclusion by constructing a logic diagram called a fault tree
- The basic symbols used in an FTA logic diagram are called logic gates and are similar to the symbols used by electronic circuit designers. Two kinds of gates are used: "and" and "or"



# Methods—Fault Tree



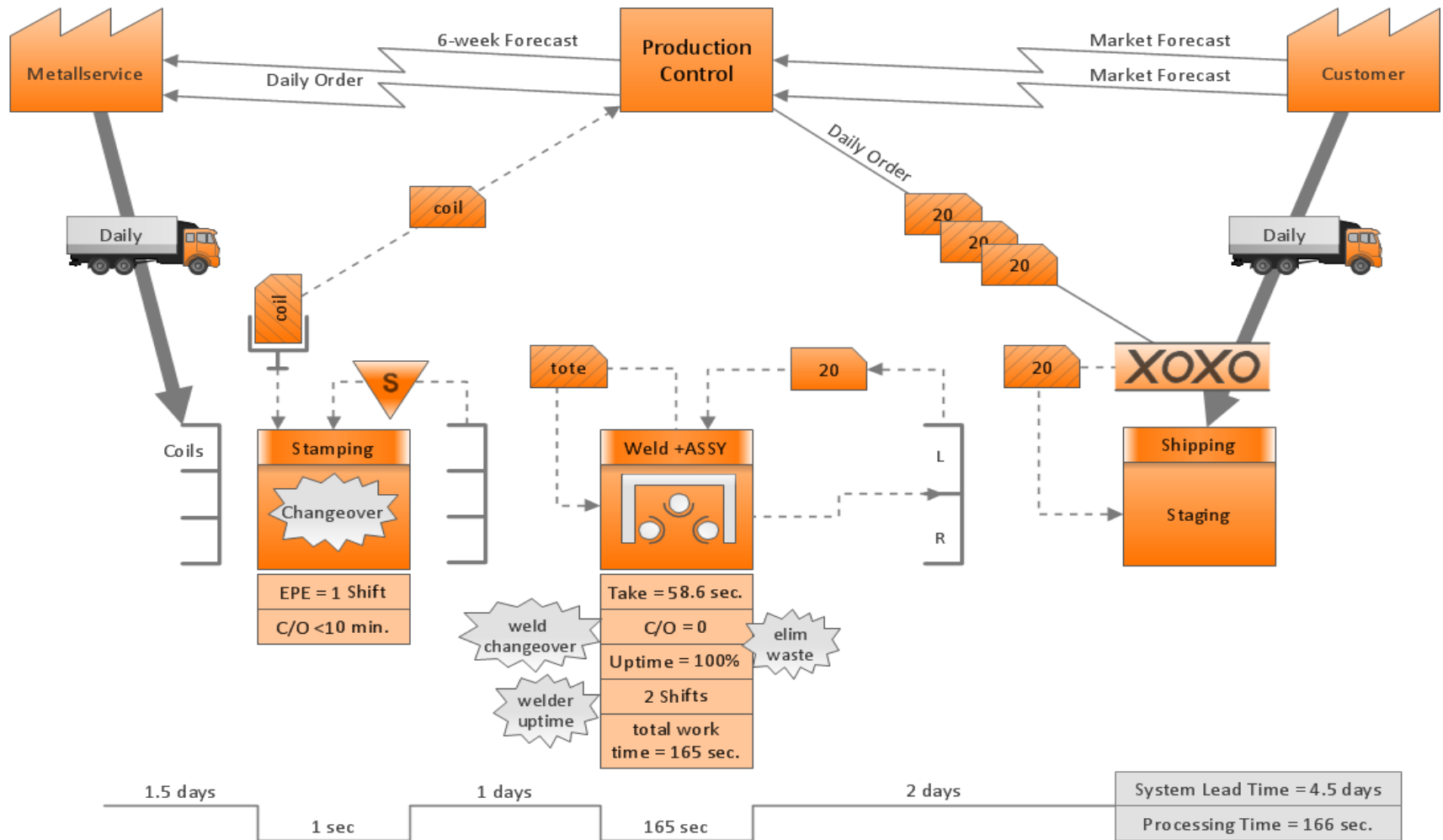


# Methods—Failure Modes and Effective Analysis

- Similar to Fault Tree, but its primary application is in the design of engineered systems, not specifically RCA and does not capture human aspects
- Identifies components and lists possible failures, then assigns the consequences (effects) of that failure
- Can use a ranking of the failures to prioritize
- Could be a subset or element of a RCA
- Can be a proactive, preventive tool that avoids incidents from occurring due to design or component failure



# Methods–Failure Modes and Effective Analysis



C/O = Changeover Time; EPE = every time every -



# Methods–Storytelling

- Not RCA, but is the most common form of incident “investigation”
- Typically utilizes a pre-printed form (Incident Report) that may be internally created, or based on codes used by insurers for actuarial purposes
- Fails to identify and address causation
- Primary objective is to document events and selected details, but does not include analysis of the incident
- Action items/follow-up typically not part of the process



# Methods—Incident Report Form

**Incident Reporting Form**

Use this form to report any workplace accident, injury, incident, close call or  
Return completed form to the Operations Supervisor, or Management

**This is documenting an:**

☐ ☐ ☐ ☐

Lost Time/Injury      First Aid      Incident      Close Call

**Details of person injured or involved** (to be filled in by person injured / involved if

Person Completing Report: \_\_\_\_\_ Date: \_\_\_\_\_

Person(s) Involved: \_\_\_\_\_

Equipment or Truck ID: \_\_\_\_\_

**Event Details**

Date of Event: \_\_\_\_\_ Location of Event: \_\_\_\_\_

Time of Event: \_\_\_\_\_ Witnesses: \_\_\_\_\_

**Description of Events** (Describe tasks being performed and sequence of events):

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

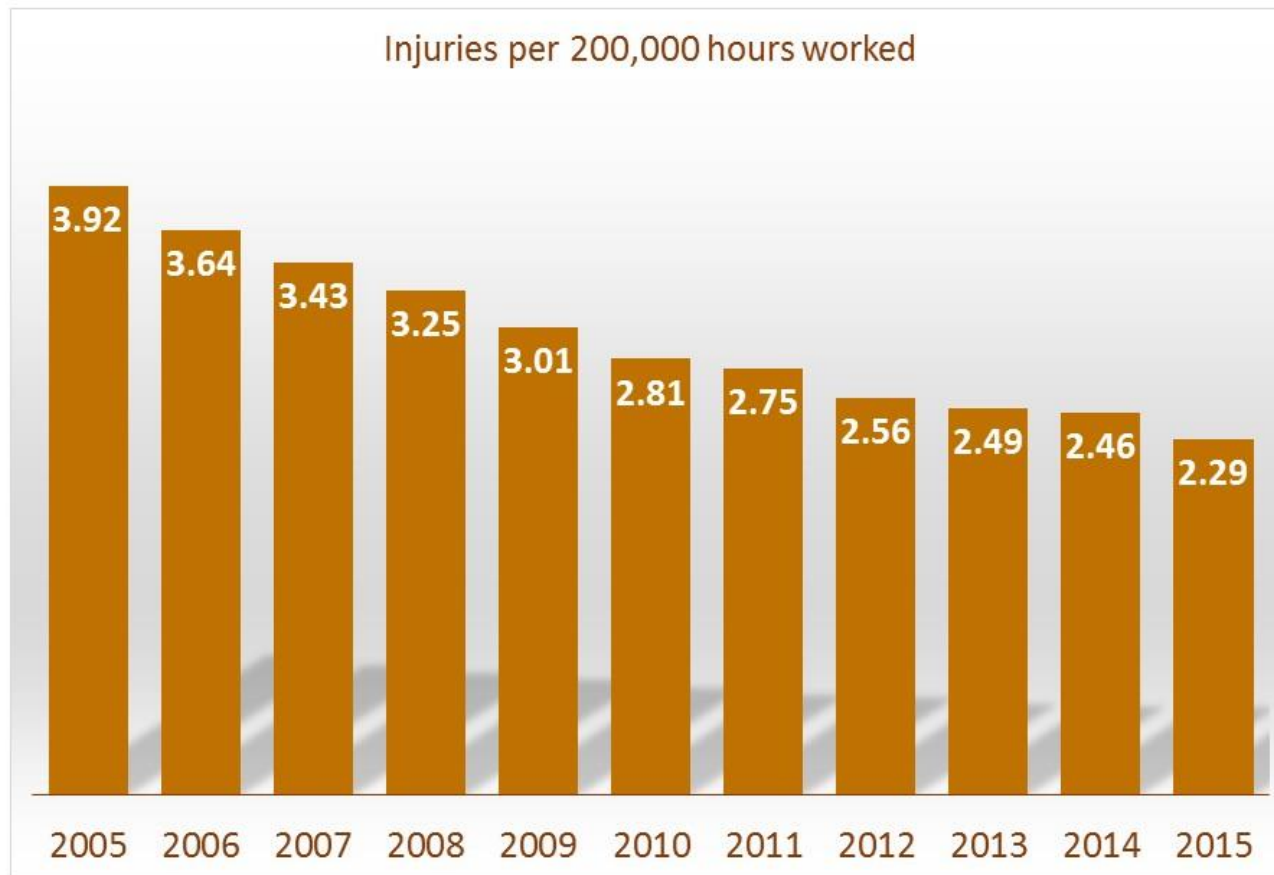


# Methods–Pareto Analysis

- Uses a database of “events” to quantify pre-determined causal factors
- Accuracy is limited by the quality of the data used/chosen to reflect cause
- Based on the 80-20 Rule (80% of incidents are caused by 20% of the causes)
- It directs resources at the most common causes
- Trends frequency
- Driven by the premise that all causes and effects are part of the same continuum (if A happens, B will occur)—the causal connection is lost
- Can mask larger, more systemic issues (cant see the forest for the trees)



# Methods–Pareto Analysis



Data compiled by National Mining Association using 2015 statistics from on U.S. Mine Safety and Health Administration, <http://www.nma.org/index.php/safety-statistics>



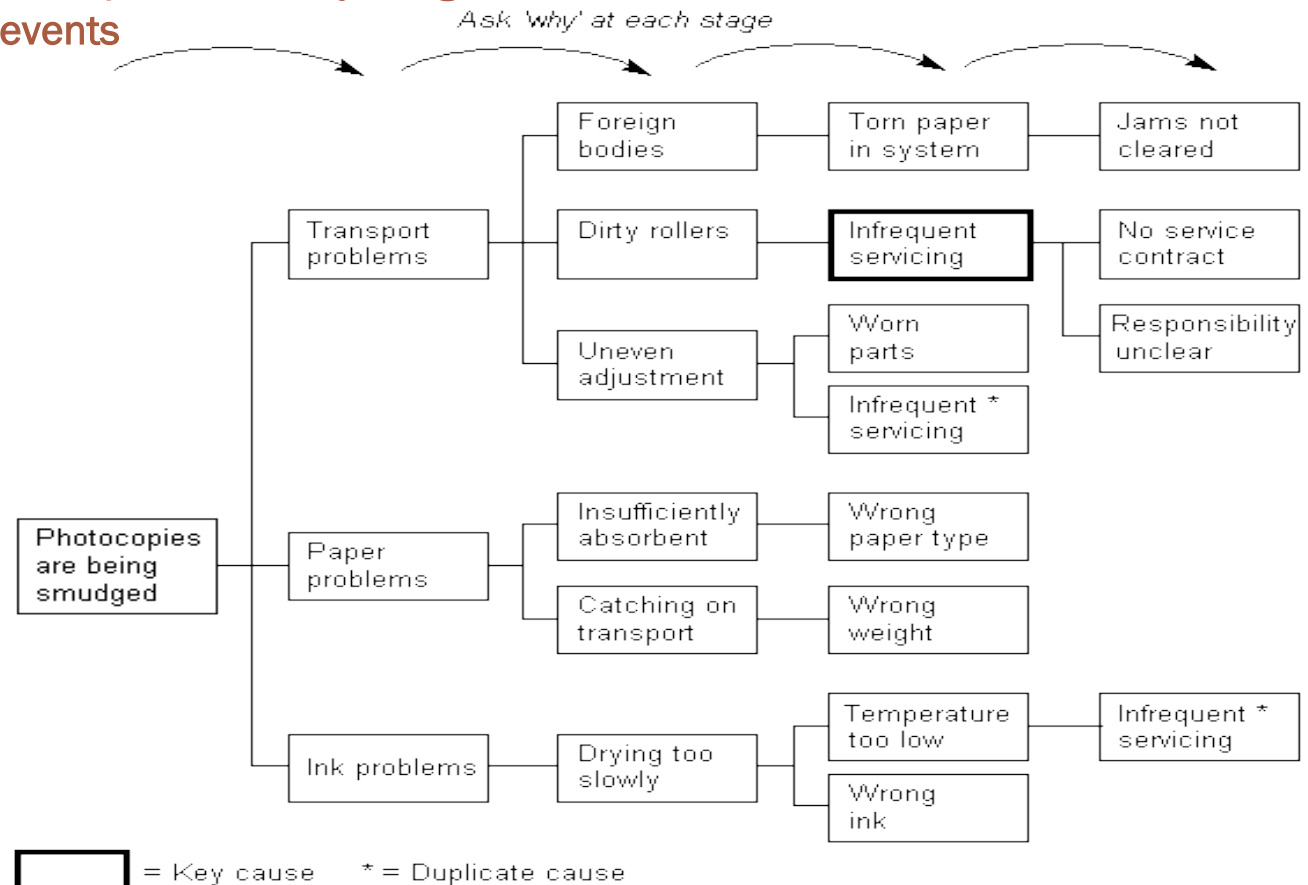
# Methods—the Five Whys

- Comes from Six Sigma (a quality management system) that utilizes Define, Measure, Analyze, Improve, Control
- Does not require statistical analysis
- Is not a rigid process, but involves asking “Why” until the question becomes irrelevant or unproductive—the process can end after 3 “Whys” if the answer results at that point
- Is the most basic type of RCA
- Define the cause and effect factors using another method, such as Bowtie or Fish bone, then begin asking why....



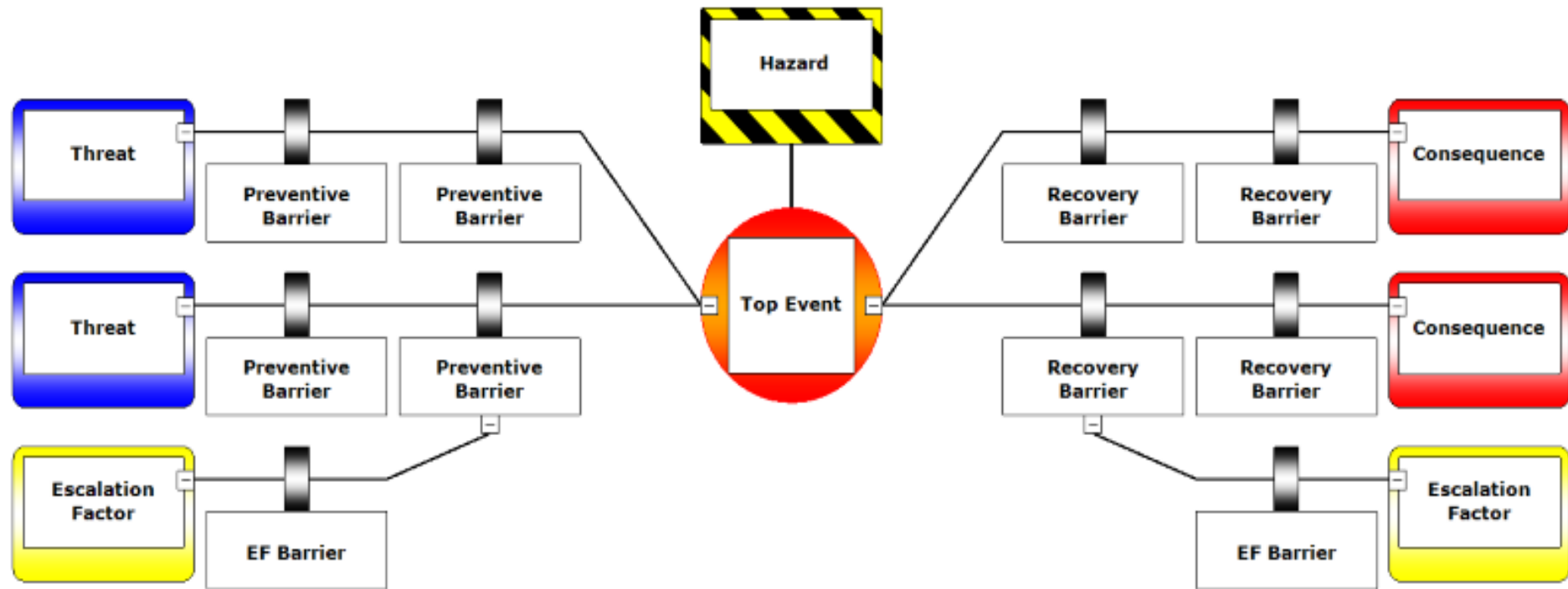
# Methods– Why-Why Chart

- Involves asking “WHY” multiple times (typically 5 times) until there is no answer—the most basic form of RCA
- Does identify causal factors/relationships
- Defines linear relationships, which may not get to root causes, and is not beneficial for more complicated events



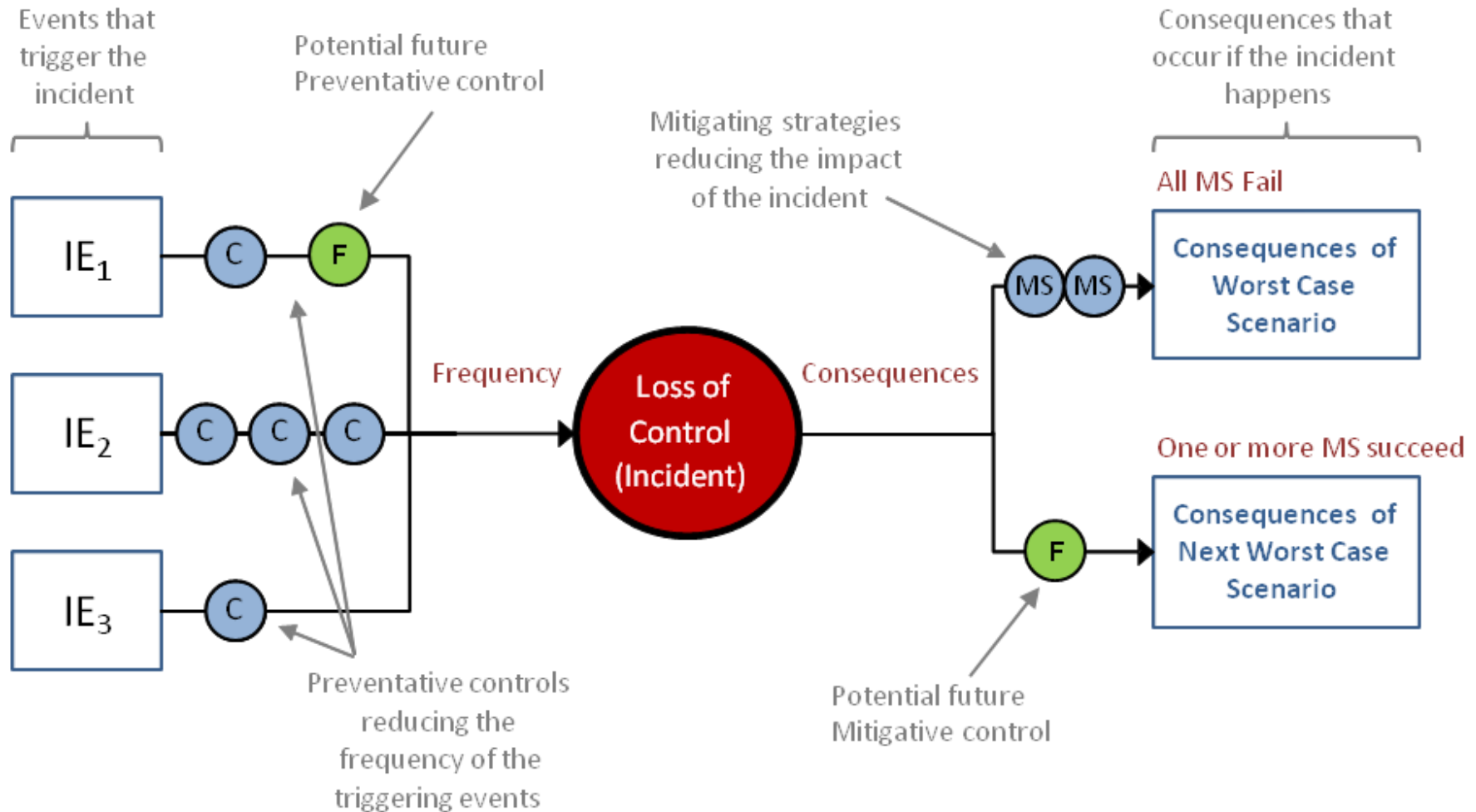


# Methods—Bowtie (“barrier analysis”)





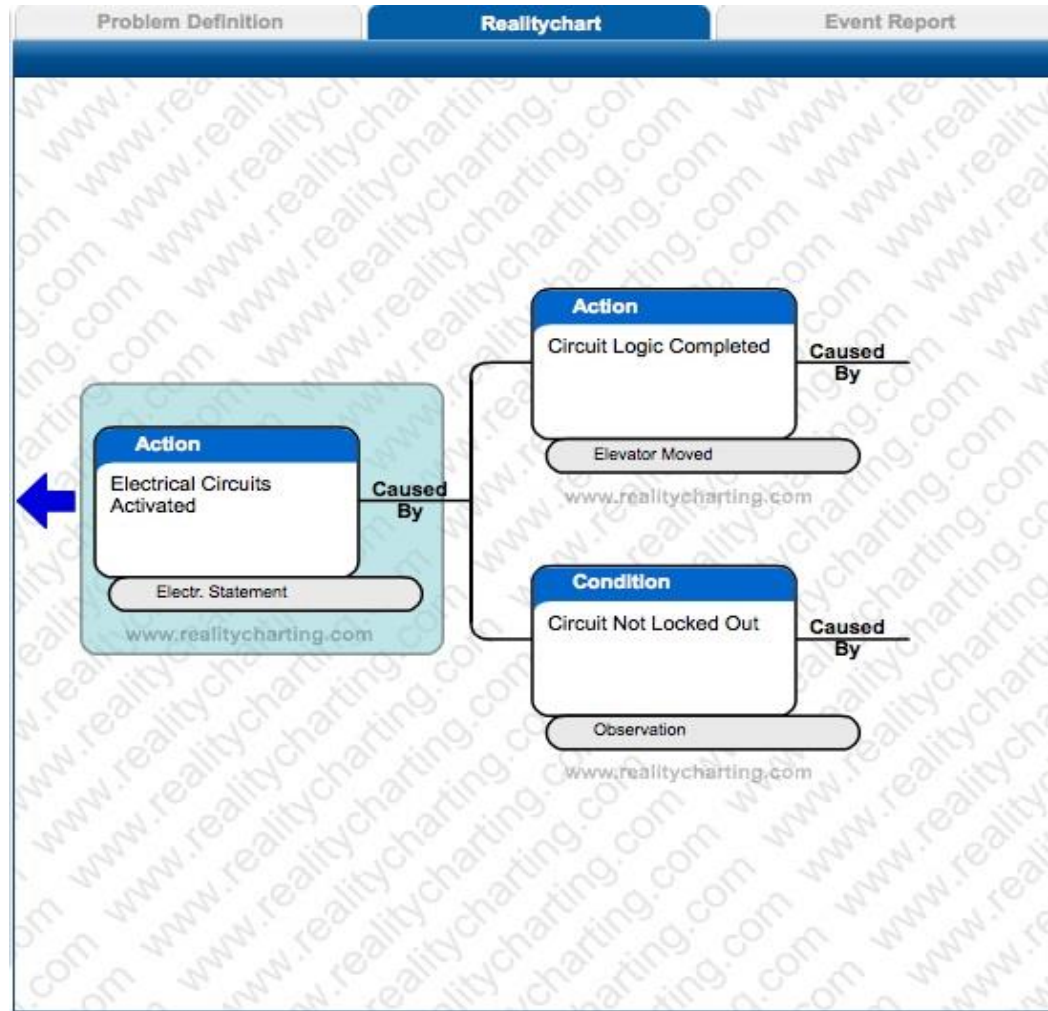
# Methods—Bowtie (“barrier analysis”)





# Method—RealityCharting®

Each effect has at least two causes in the form of actions and conditions





# Method—RealityCharting®

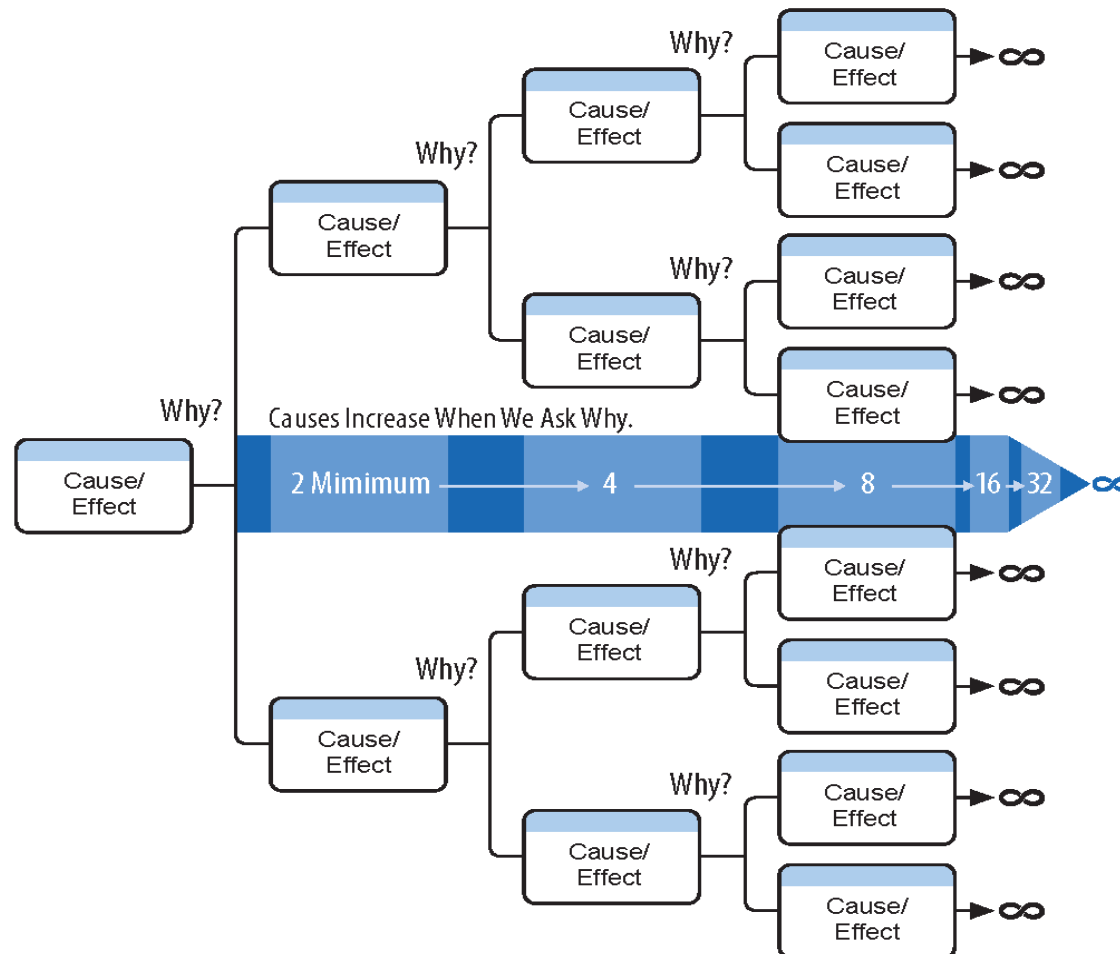
Cause and effect are the same thing

Effects		Causes
Injury	Caused By	Fall
Fall	Caused By	Slipped
Slipped	Caused By	Wet Surface
Wet Surface	Caused By	Leaky Valve
Leaky Valve	Caused By	Seal Failure
Seal Failure	Caused By	Not Maintained



# Method—RealityCharting®

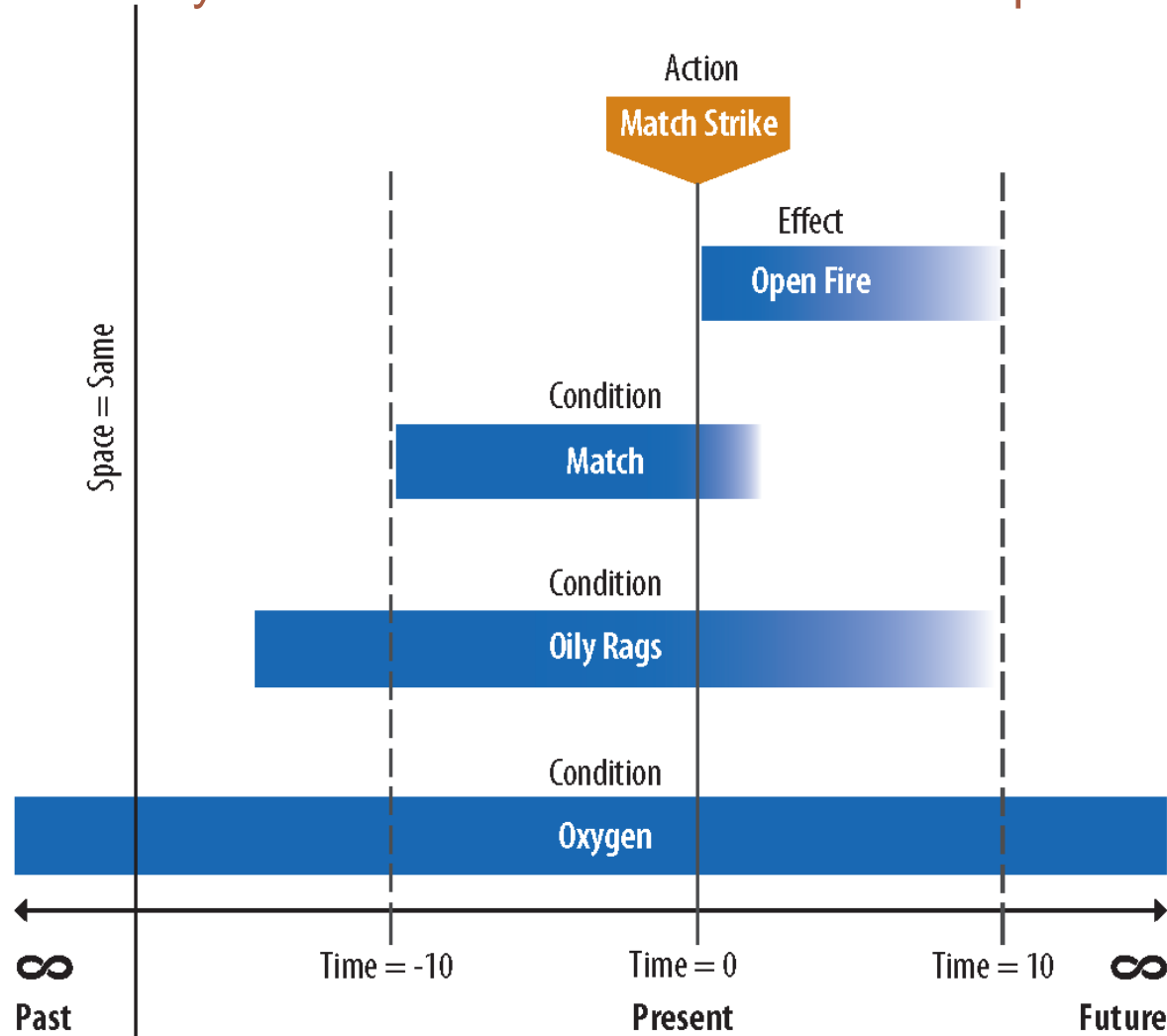
Causes and effects are part of a continuum of causes (an effect becomes a cause)





# Method—RealityCharting®

An effect exists only when causes occur in the same space and time





## Methods—Comparison (full disclosure)

Method/Tool	Type	Defines Problem	Defines All Known Causes	Provides A Causal Path To Root Causes	Delineates Evidence	Explains How Solutions Prevent Recurrence	Easy To Follow Report	Score
Events & Causal Factors	Method	Yes	Limited	No	No	No	No	1.5
Change Analysis	Tool	Yes	No	No	No	No	No	1
Barrier Analysis	Tool	Yes	No	No	No	No	No	1
Tree Diagrams	Method	Yes	No	No	No	No	No	1
Why-Why Chart	Method	Yes	No	Yes	No	No	No	2
Pareto	Tool	Yes	No	No	No	No	No	1
Storytelling	Method	Limited	No	No	No	No	No	0.5
Fault Tree	Method	Yes	Yes	Yes	No	Yes	No	4
FMEA	Tool	Yes	No	Limited	No	Limited	No	2
<b>RealityCharting®</b>	<b>Method</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>6</b>



# Resources

Any combination of the following perspectives/disciplines to provide input and details of the incident and identify causative factors:

- Supervisor
- H&S
- Maintenance
- Worker
- Technical Expert
- Facilitator



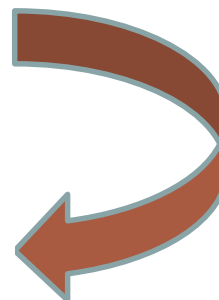
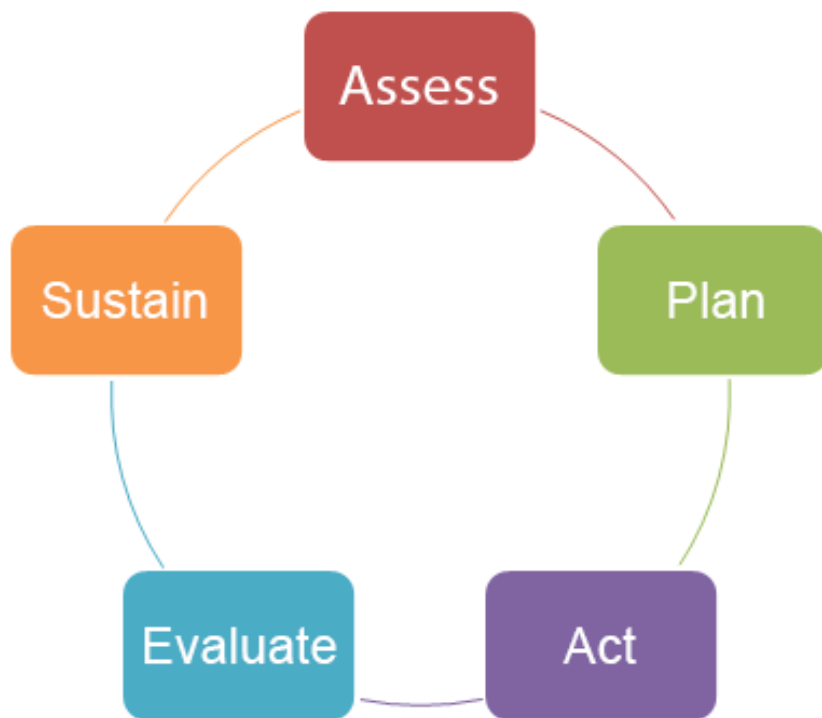
# Preparation

- Commit to RCA and get management support and involvement
- Decide on the method or combination of methods
- List elements and define them—list is not fixed or inflexible
- Identify resources and alternates
- Conduct training on the process—modify process as needed
- Have system to track recommendations to conclusion/implementation



# Delivering Prevention

—RCA is not the End, it's a continuum



**Prevent repetition  
and/or minimize the  
severity of an incident.**



**Thank you**