

AQS 200

ROOT CAUSE INVESTIGATION

This material is based upon work supported
by the National Science Foundation under
Grant No. 1304474



Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

LECTURE 10

TOOLS FOR

ROOT CAUSE IDENTIFICATION

- Matrix Diagrams
- Cause and Effect
- Five Whys
- Fault Tree Analysis



Matrix Diagrams

Matrix Diagrams

- investigate a number of possible causes
- determine which contributes most to the problem
- graphically portray multiple connections

Used for

- Mapping overall impact
- Which cause is most prominent

Matrix Diagrams

- Several types (shapes)
 - Based on the number of concepts (causes) being compared
 - Descriptive of how diagram is constructed

Shapes:

Roof

T

L

X

Y

Utilize combination of symbols and numerical weights to visualize relationships and impact

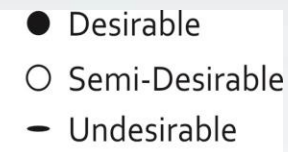
Matrix Diagrams - TYPES

- Roof-shaped:
 - relates one group of items to itself

Diagrams - *Roof-Shaped*

- Desirable
- Semi-Desirable
- Undesirable

Row	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
1	●									
2		○								
3	●		○							
4	●	○		-						
5	●		-		○					
6	-		-	○	○	○			●	
7	-	○	○	○	○	○			●	●
8	●	○	○	○	○	○			●	
9	●	○	●	○	○	○				
10	○	●	-							
11		-								
12		-								
13		-								



Matrix Diagrams - TYPES

- L-shaped: *comparison of 2-3 concepts (causes)*
 - Relates elements on the Y-axis directly to elements on the X-axis.

Matrix Diagrams - L-Shaped

Requirements	Customer: Food	Customer: Medical Device	Customer: General
Quality System Type	FDA	FDA	ISO
Process control	SPC	SPC	SPC
Capability (Cpk) minimums	1.5	1.5	1.3
Certified Quality Engineers	Yes	Yes	Optional
Supplier Certification	Yes	Yes	Yes
HAACP Program	Yes	Yes	Optional
Designed Experiments	Optional	Yes	Optional
FMEA	Yes	Yes	Yes

Matrix Diagrams - TYPES

- T-shaped: *comparison of 2-3 concepts (causes)*
 - relates 2 elements on the Y-axis that are split by elements on the X-axis

Matrix Diagrams - T-Shaped

Texas plant	●		○	○
Mississippi plant		●		○
Alabama plant	○			●
Arkansas plant		○	●	
● Large volume ○ Small volume	Model A	Model B	Model C	Model D
Zig Corp.		●		
Arlo Co.	○	○	○	●
Lyle Co.			○	○
Time Inc.	●			●

Matrix Diagrams - TYPES

- X-shaped:
 - relates 4 elements 2 on the Y-axis divided by 2 elements on the X-axis

Matrix Diagrams - X-Shaped

○		●	○	Texas plant	●		○	○
	○	●	●	Mississippi plant		●		○
		●	●	Alabama plant	○			●
○	○		○	Arkansas plant		○	●	
Red Lines	Zip Inc.	World-wide	Trans South		Model A	Model B	Model C	Model D
		●	○	Zig Corp.		●		
			●	Arlo Co.	○	○	○	●
○	○			Lyle Co.			○	○
	○	●		Time Inc.	●			●

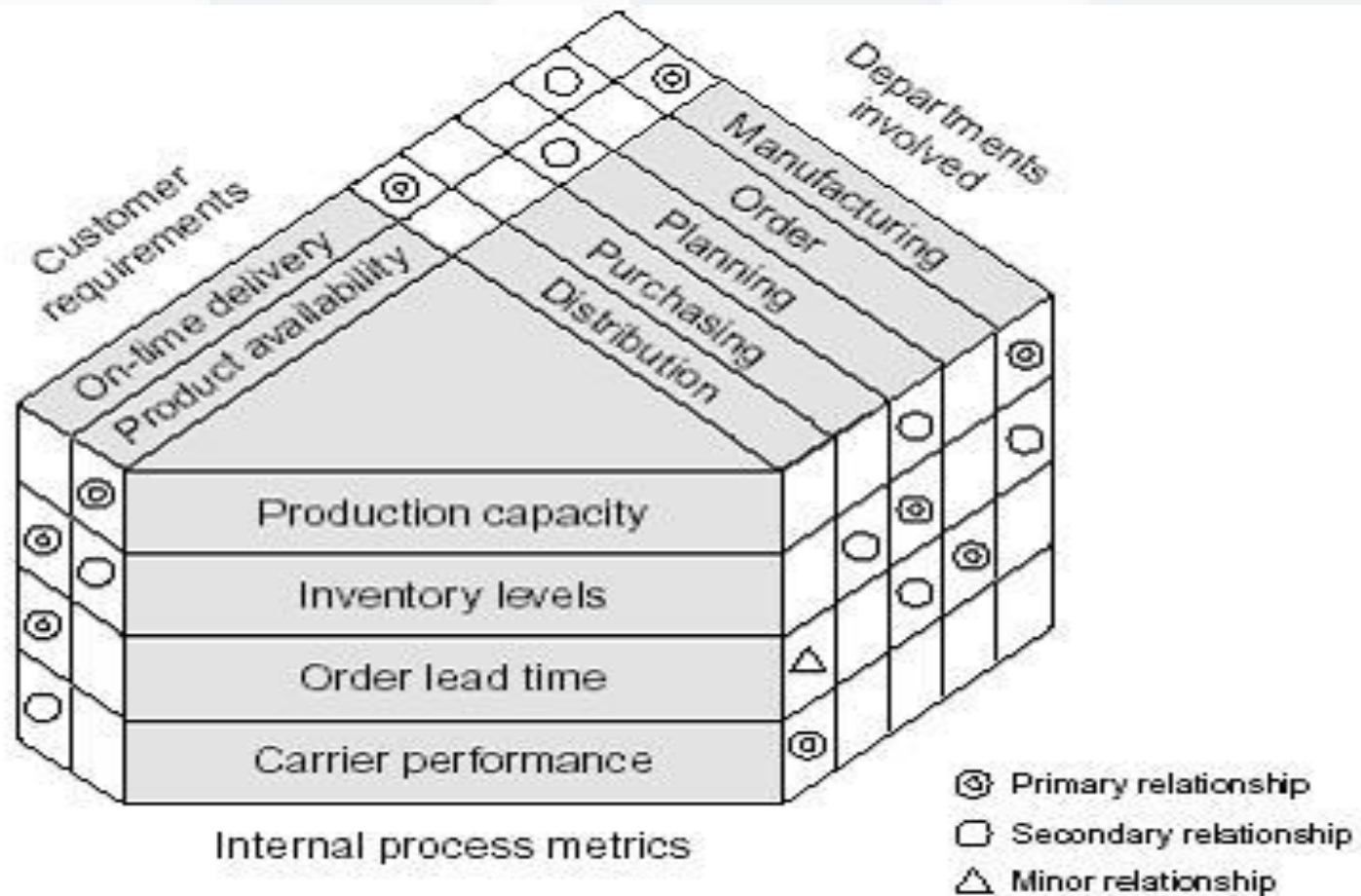
● Large volume

○ Small volume

Matrix Diagrams - TYPES

- Y-shaped
 - 2 L-type matrices joined at the Y-axis to produce a matrix design in 3 planes.

Matrix Diagrams - Y-Shaped



Matrix Diagrams – Which One




↔	L-shaped	2 groups	$A \leftrightarrow B$ (or $A \leftrightarrow A$)
	T-shaped	3 groups	$B \leftrightarrow A \leftrightarrow C$ but not $B \leftrightarrow C$
	Y-shaped	3 groups	$A \leftrightarrow B \leftrightarrow C \leftrightarrow A$
	C-shaped	3 groups	All three simultaneously (3-D)
	X-shaped	4 groups	$A \leftrightarrow B \leftrightarrow C \leftrightarrow D \leftrightarrow A$ but not $A \leftrightarrow C$ or $B \leftrightarrow D$
	Roof-shaped	1 group	$A \leftrightarrow A$ when also $A \leftrightarrow B$ in L or T

Matrix Diagrams – HOW TO

L-Shaped will be the one reviewed

Matrix Diagrams – How To

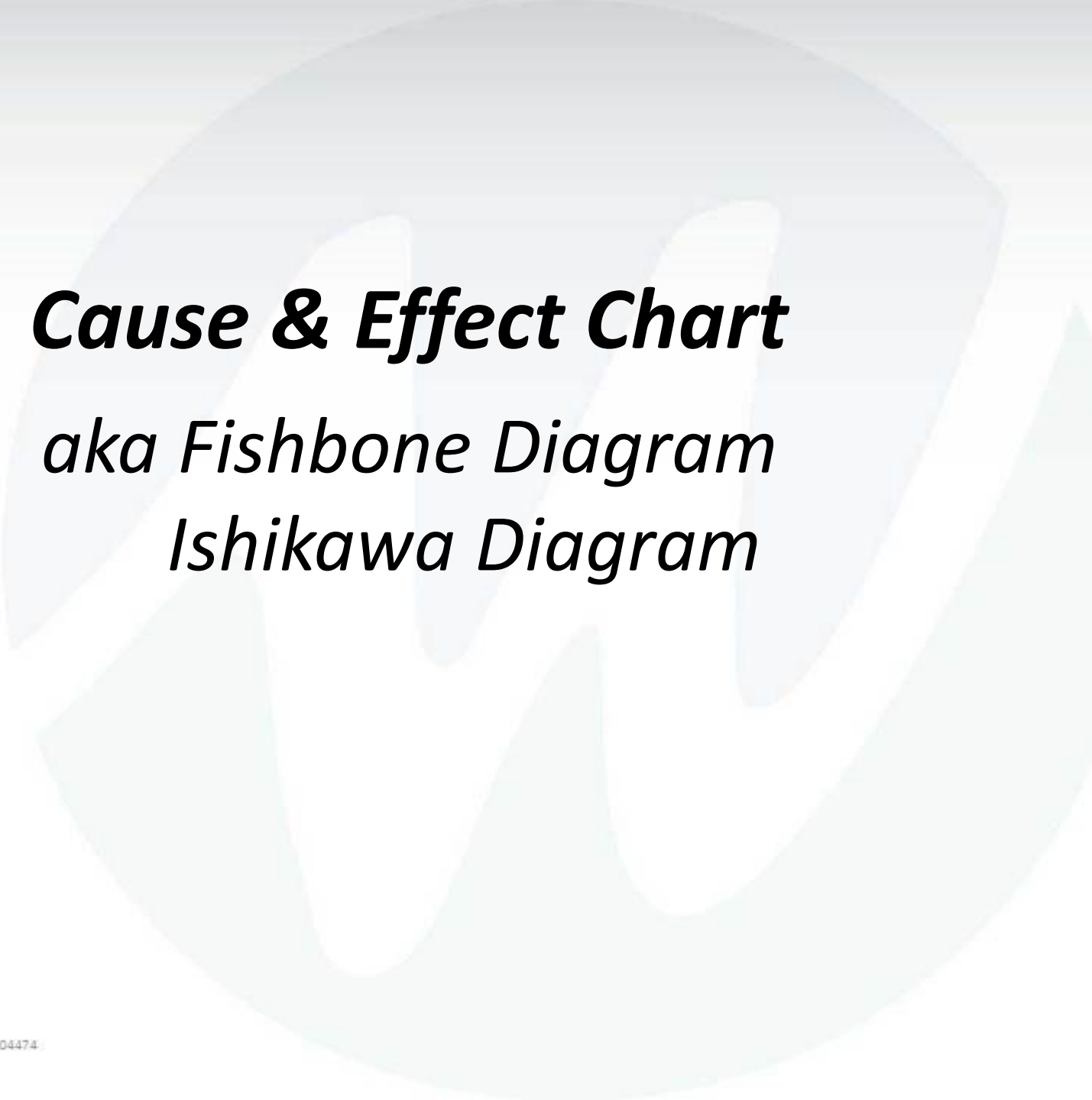
1. Select the problem characteristics and possible causes to be analyzed for types and levels of relationships.
2. Create an empty matrix of suitable size.
3. Plot the variables on the diagram.
4. Indicate impacts using symbols or numerical weights

Relation	Symbol	Weight
Weak		1
Medium		3
Strong		9

Matrix Diagrams – How To

1. Select the problem characteristics and possible causes to be analyzed for types and levels of relationships.
2. Create an empty matrix of suitable size.
3. Plot the variables on the diagram.
4. Indicate impacts using symbols or numerical weights
5. For each column in the diagram , calculate the total impact and present the sum.
6. Possible causes with large sum are likely root causes.

Matrix Diagrams - EXERCISE

A large, faint, light blue fishbone diagram is centered in the background of the slide. It consists of a horizontal spine with two diagonal ribs on each side, forming a shape reminiscent of a fish skeleton.

Cause & Effect Chart

aka Fishbone Diagram

Ishikawa Diagram

Cause & Effect Charts

- Analyzes relationships between a problem and its causes
 - combines aspects of brainstorming with systematic analysis
- Purpose is to understand what cause(d) problem
- Used to
 - Generate and group problem causes
 - Systematically evaluate which are most likely root cause(s)

Cause & Effect Charts

- Created by Kaoru Ishikawa in 1960's
 - Materials
 - Methods
 - Machine
 - Manpower
 - Measurement
 - Environment (“Mother Nature”)
 - *Management*
 - *Maintenance*

Cause & Effect Charts

- Two Types

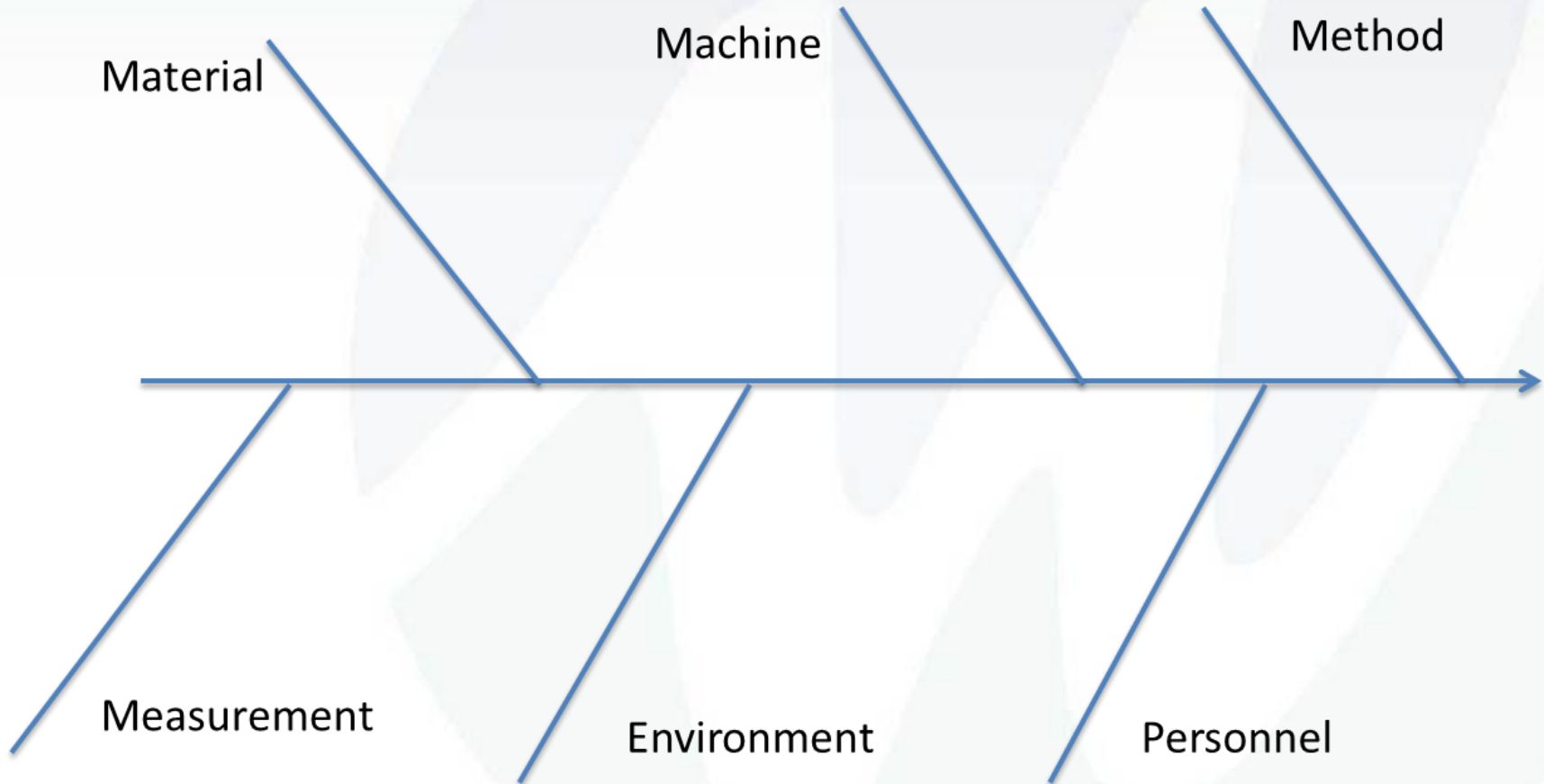
1. *Fishbone Chart*

- *Traditional method*
- *Shape resembles a fishbone*

2. *Process Chart*

- More direct focus on analysis of internal process problems
- For each step of the process a fish bone chart is constructed to address all potential causes of less-than-expected performance.
- Collective analysis is conducted to identify the causes of highest importance.

Fishbone Diagram (Chart)



Cause & Effect Charts

- Materials
 - Raw materials used to produce the final product
- Methods
 - How process performed
 - Specific requirement for doing it
- Machine
 - Equipment, tools, computers used to accomplish the job
- Manpower
 - Anyone involved in the process
- Measurement
 - Data generated from process
- Environment
 - Conditions (location, time, temperature, culture etc.)

Cause & Effect Charts - Fishbone

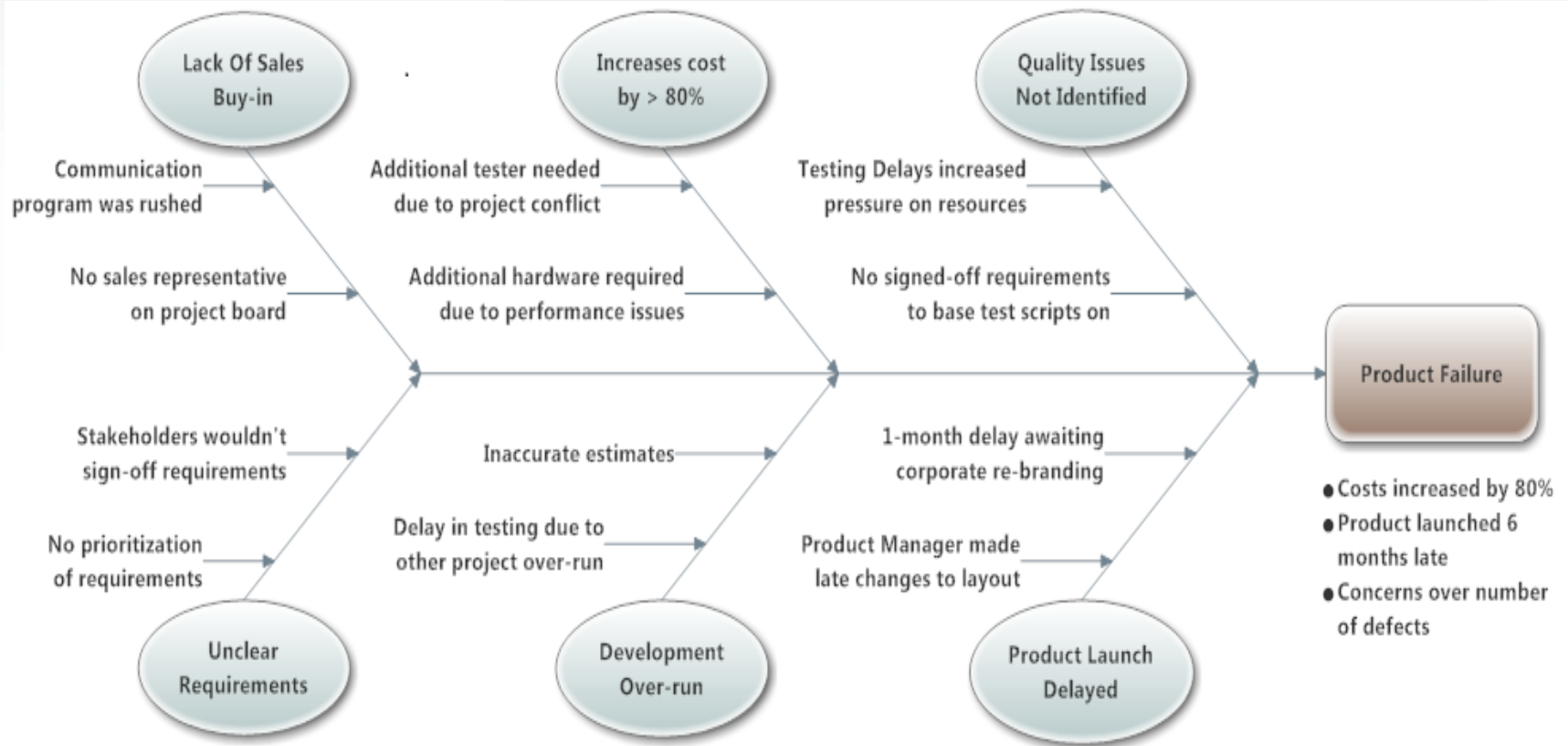
- two different ways to create
 - *Dispersion analysis*
 - *Cause enumeration*

Cause & Effect Charts - Fishbone

- two different ways to create
 - *Dispersion analysis*
 - *Traditional method which brainstorms probable causes for each category*
 - *Cause Enumeration*
 - All probable causes are brainstormed and listed in the order they are generated.
 - The causes are then grouped into main categories and written on the fishbone chart.

Lecture will focus on dispersion analysis --- Traditional method

Cause & Effect Chart - Example



Action Plan:

- Carry out review of testing approach and procedures (QA Manager)
- Source suitable requirements and estimating training for development team (HR)
- Arrange meeting with Sales to revitalize product support (Project Manager)
- Revisit project communications to ensure clear project message has been given (Project Manager)

Cause & Effect Charts - Steps

1. Clearly describe the problem
2. Using a whiteboard or some other large surface, draw the problem at the right end of a large arrow. Allow space for the causes to be generated.

Do not strive for symmetry and graphic effects.

3. Identify the main categories of causes of the problem and write them on branches emanating from the large arrow.
 - Typically use Method, Machine, Material, Personnel (Man)
 - Environment, Measurement as applicable

Cause & Effect Charts - Steps

4. Proceed through the chart one main category at a time. Write causes that belong under more than one category in all relevant positions.
5. Analyze the identified causes to determine most likely ROOT cause

EXERCISE

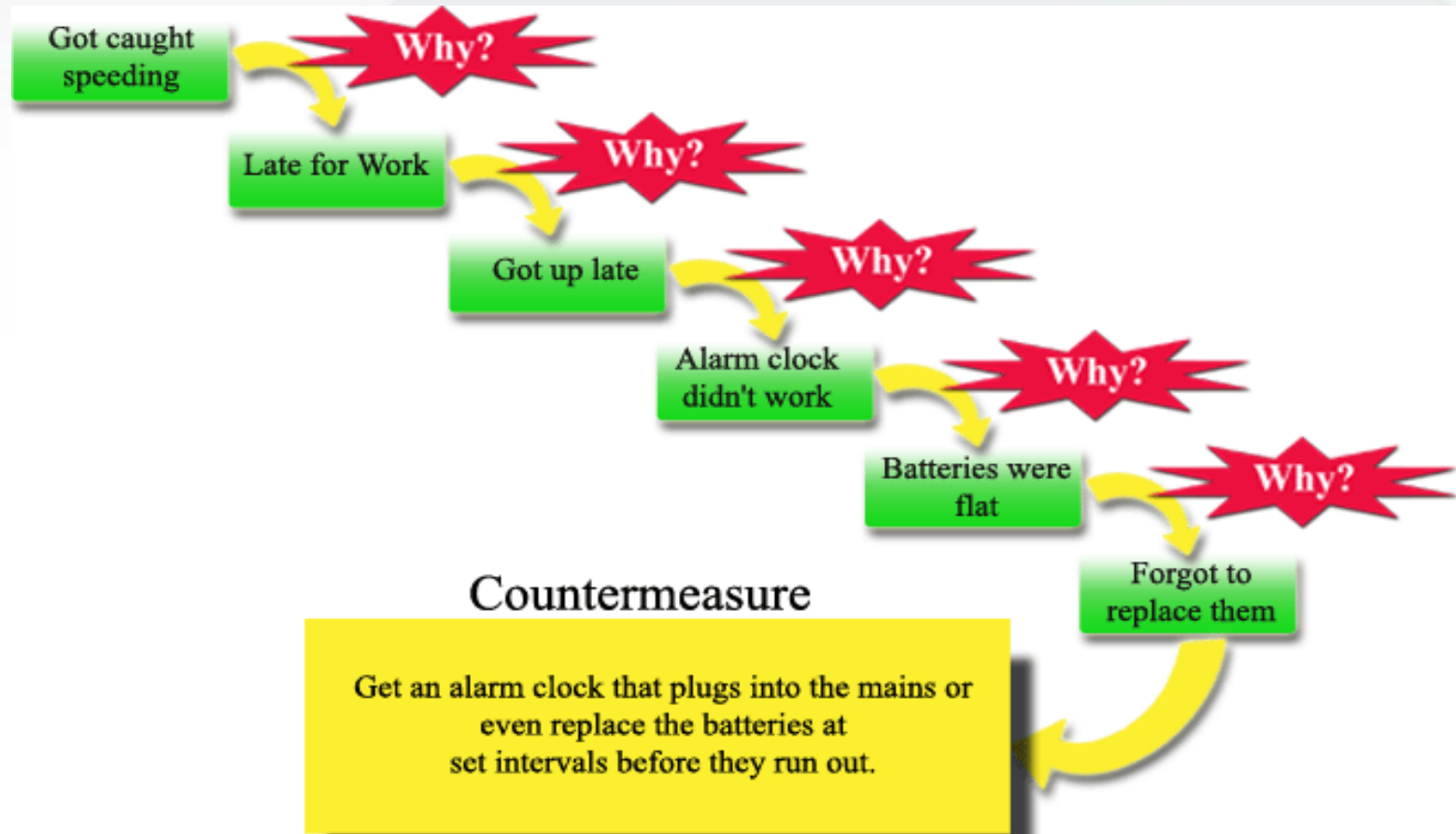


Five Whys

Five Whys

- Delves deeper into the levels of causes
 - Start at top level cause and ask “why”
 - Cascade down until “root” is located
- Used to evaluate identified causes
 - Are they symptom, lower level or root

Five Whys - Example



Five Whys – How To

1. Determine the starting point of the analysis
 - a. Original problem or
 - b. identified cause needing further analysis
2. Identify causes below the starting point
3. For each cause identified in Step 3, ask “ Why is this a cause of the original problem”
4. Depict the chain of causes as a cascading sequence on the board/flip chart
5. For each new answer ask “Why...” again
 - a. Continue until no new answer results
6. Typically 5 iterations are needed

Five Whys – How To

1. Determine the starting point of the analysis
 - a. Original problem or
 - b. identified cause needing further analysis
2. Identify causes below the starting point
3. For each cause identified in Step 3, ask “ Why is this a cause of the original problem”
4. Depict the chain of causes as a cascading sequence on the board/flip chart

[illegible]

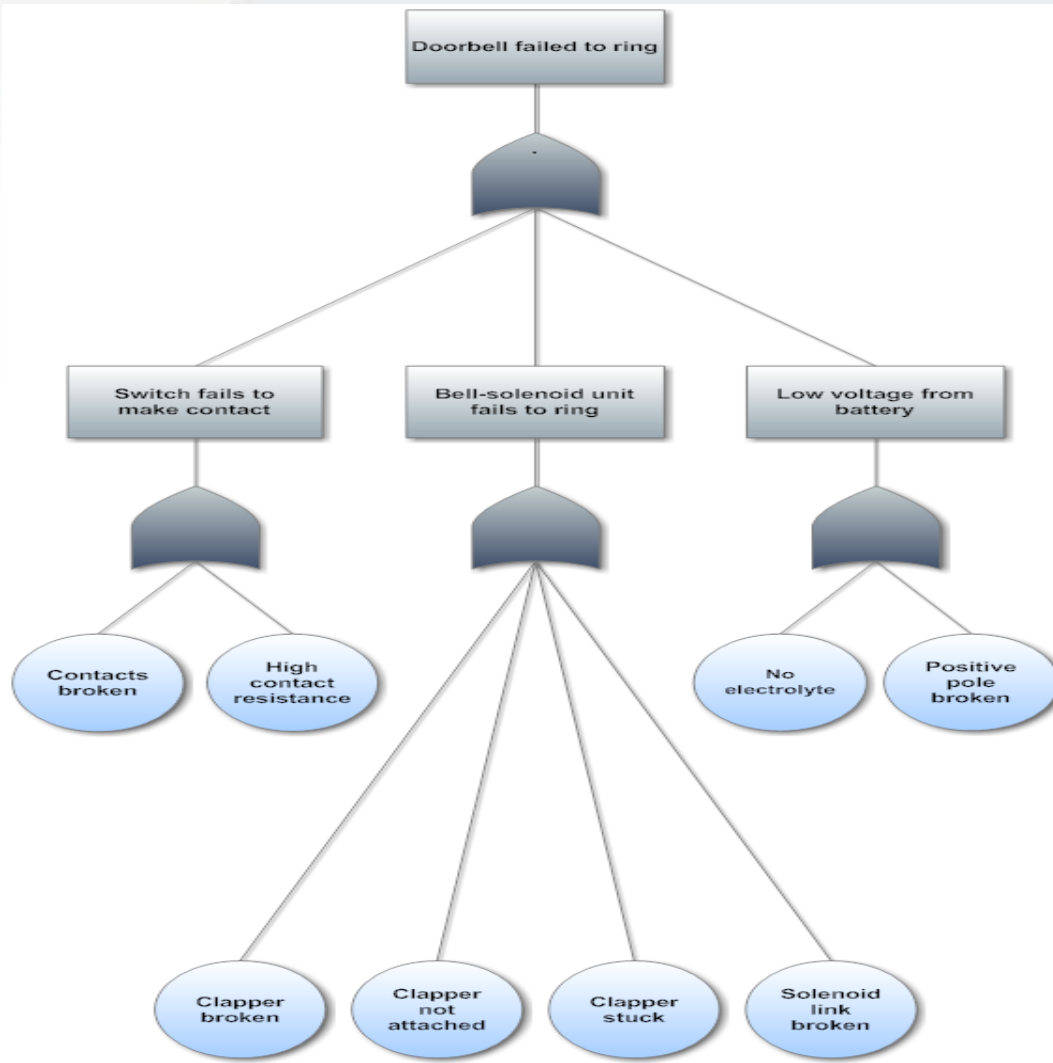
EXERCISE

Fault Tree Analysis

Fault Tree Analysis

- Risk assessment tool
 - After-the-fact analysis of problems that have already occurred
 - Foresight tool to understand possible ways things can go wrong
- Purpose
 - Clear overview of possible causes identified
 - Visualize linkages between causes
 - Identify groups of related causes

Fault Tree Analysis - Example



Fault Tree Analysis – How To

1. Identify the problem to be analyzed and place it at the top of the tree diagram. This is the **top event**.
2. Identify immediate causes directly related to top event and place on diagram
3. Evaluate the individual causes – are there lower level causes
4. Repeat steps 2 & 3 cascading down the tree until only basic causes are circled on each branch
5. Use symbols to indicate how the levels/causes operate together



AND



OR

EXERCISE

