

AQS 200

ROOT CAUSE INVESTIGATION

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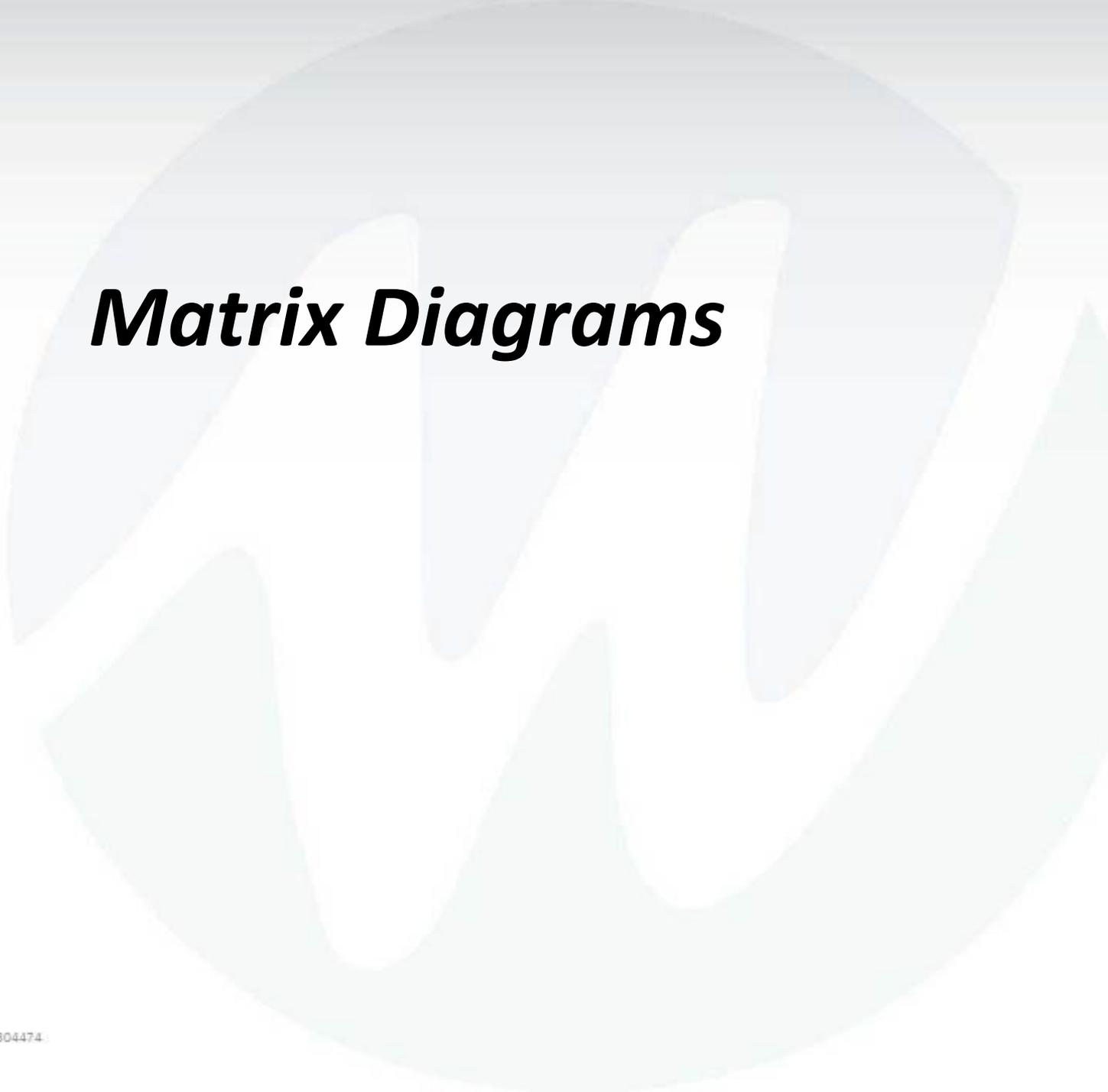
LECTURE 10

TOOLS FOR

ROOT CAUSE IDENTIFICATION

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



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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

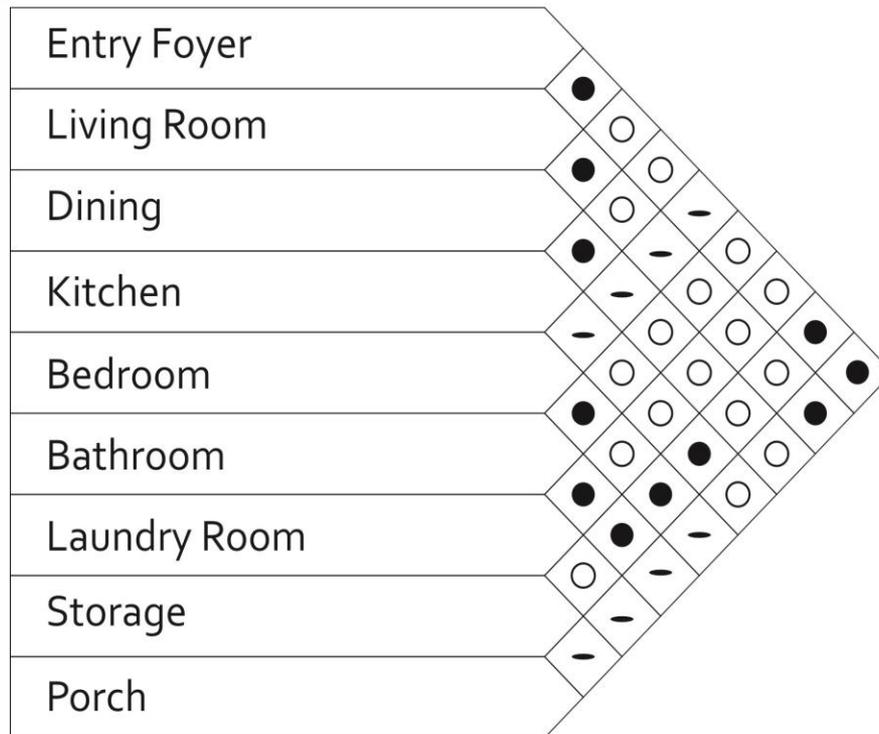
Utilize combination of symbols and numerical weights to visualize relationships and impact

Matrix Diagrams - TYPES

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

Matrix Diagrams - Roof-Shaped

- Desirable
- Semi-Desirable
- Undesirable



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. | ● | | | ● |

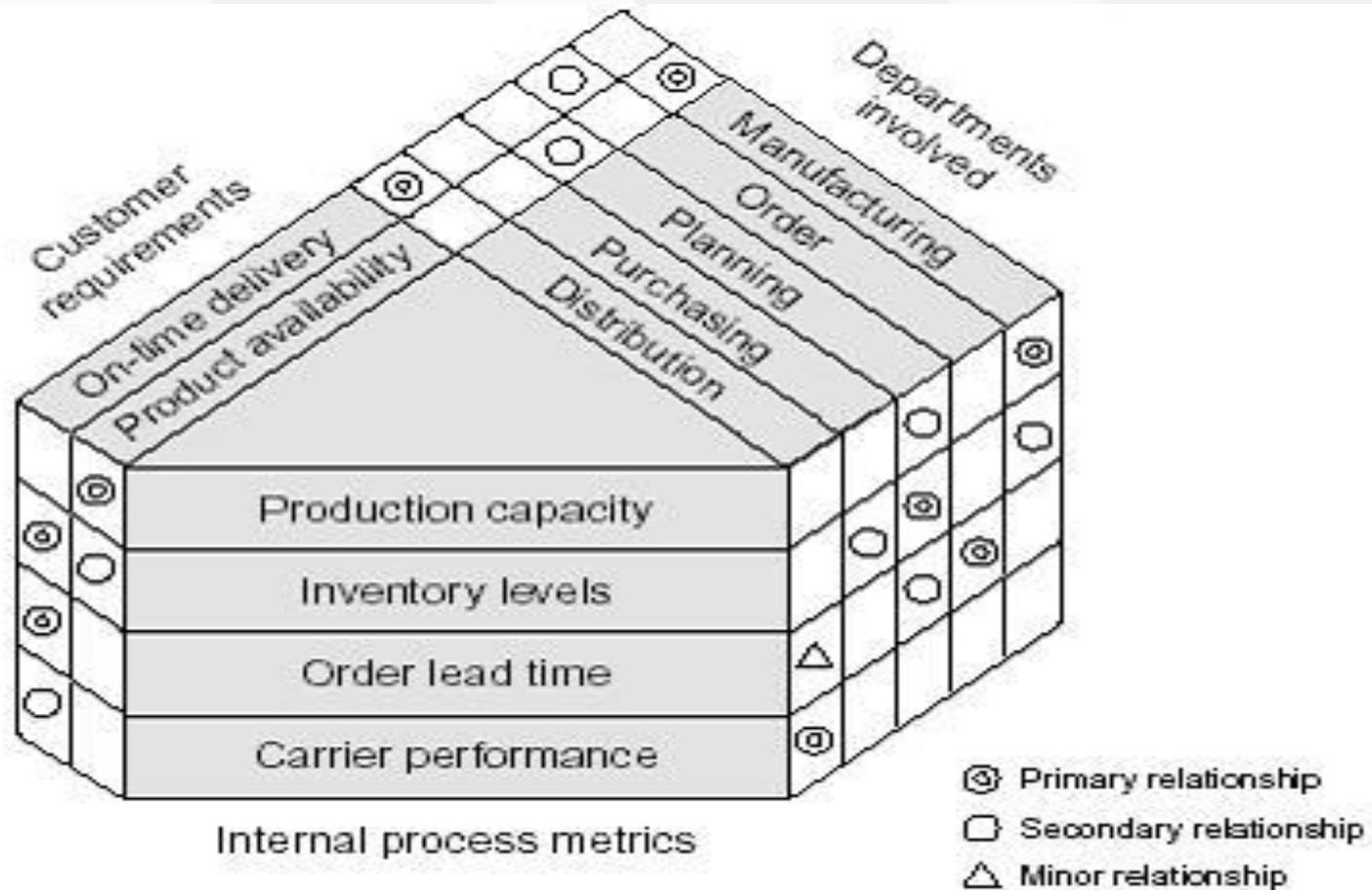
● Large volume

○ 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 $B \leftrightarrow C$ |
| \leftrightarrow | 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

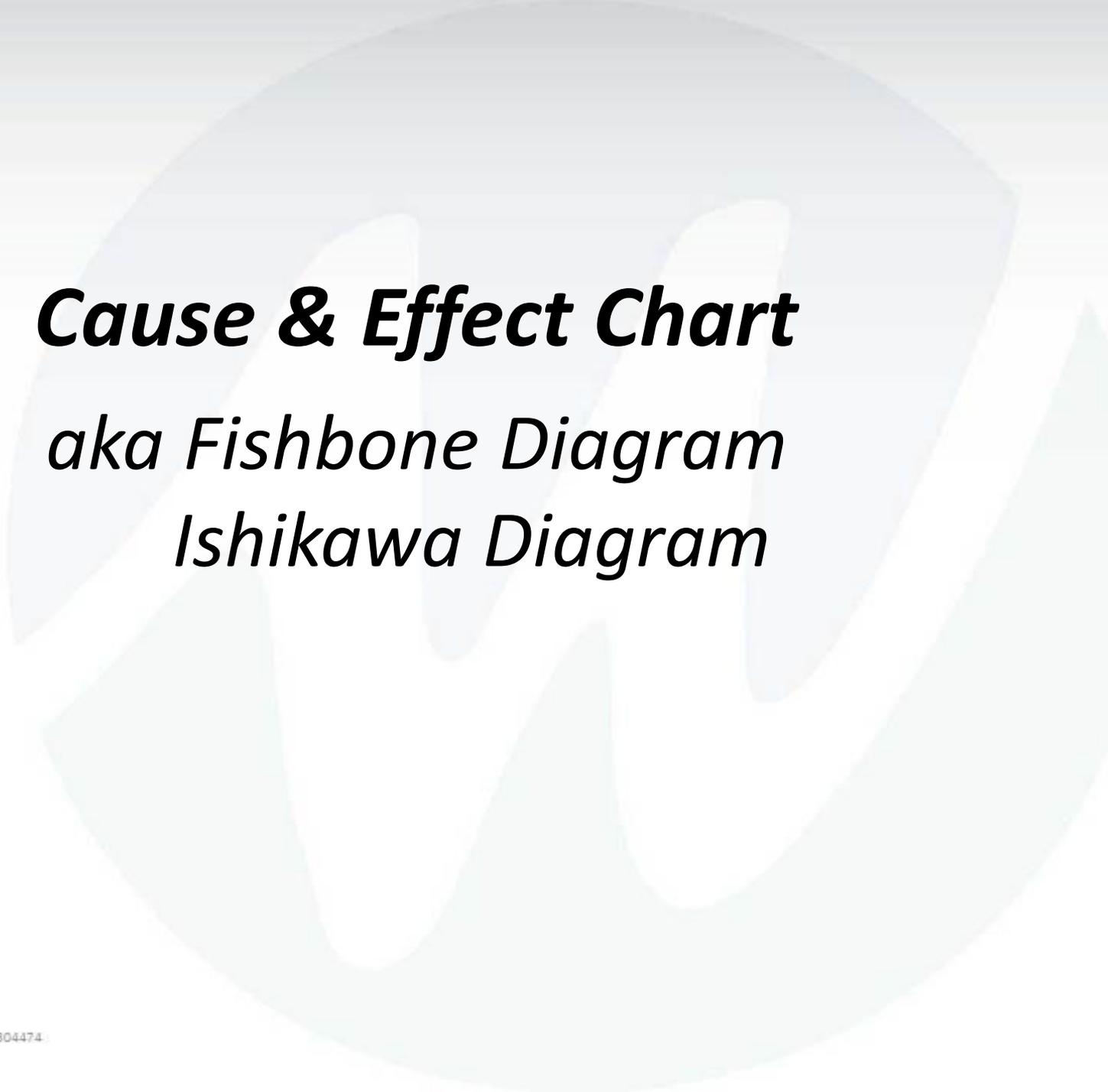
1. Select the problem characteristics and possible causes to be analyzed for types and levels of relationships.
2. Create an empty matrix of suitable size.
3. Plot the variables on the diagram.
4. Indicate impacts using symbols or numerical weights

| 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



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

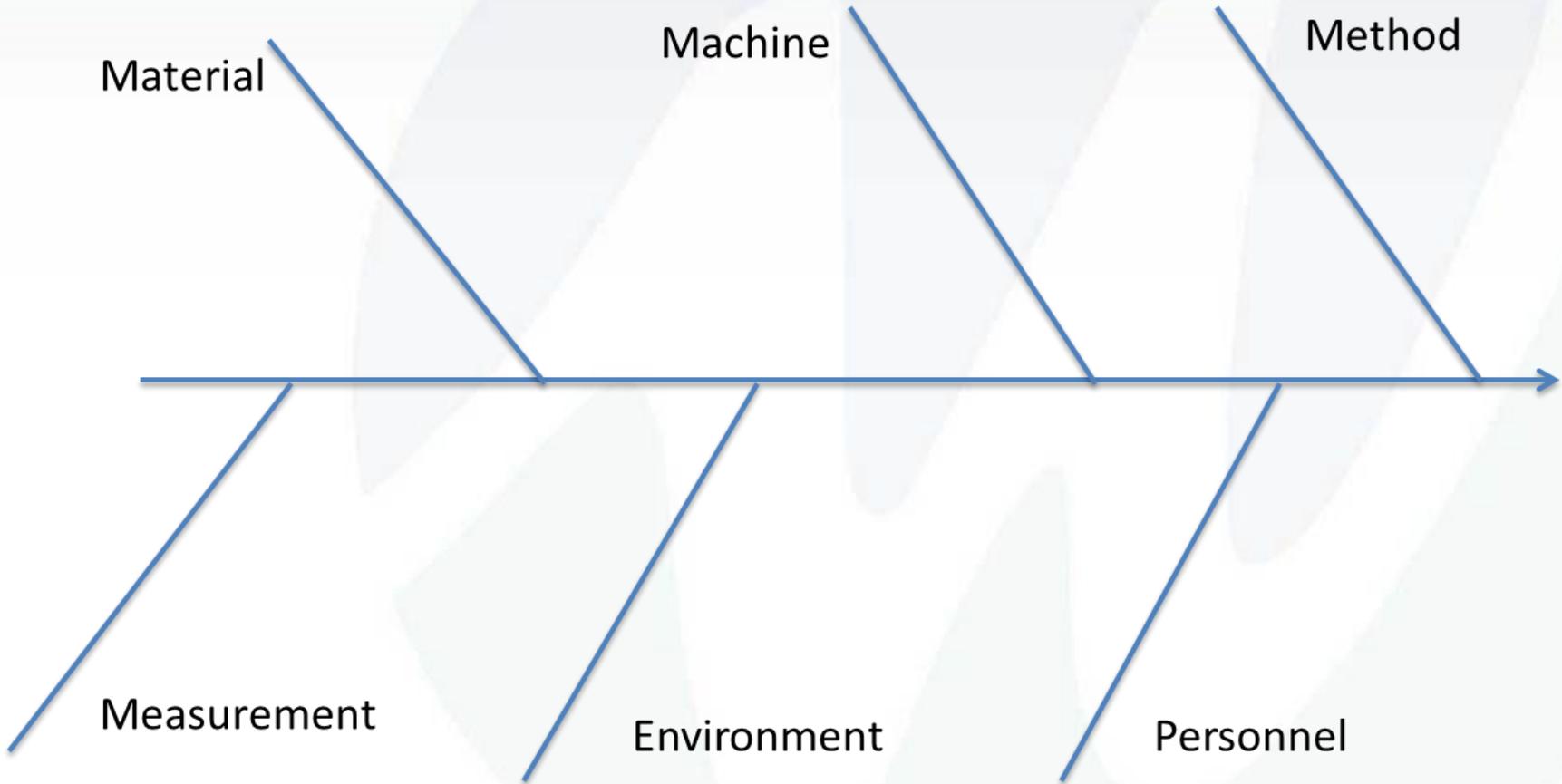
1. *Fishbone Chart*

- *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

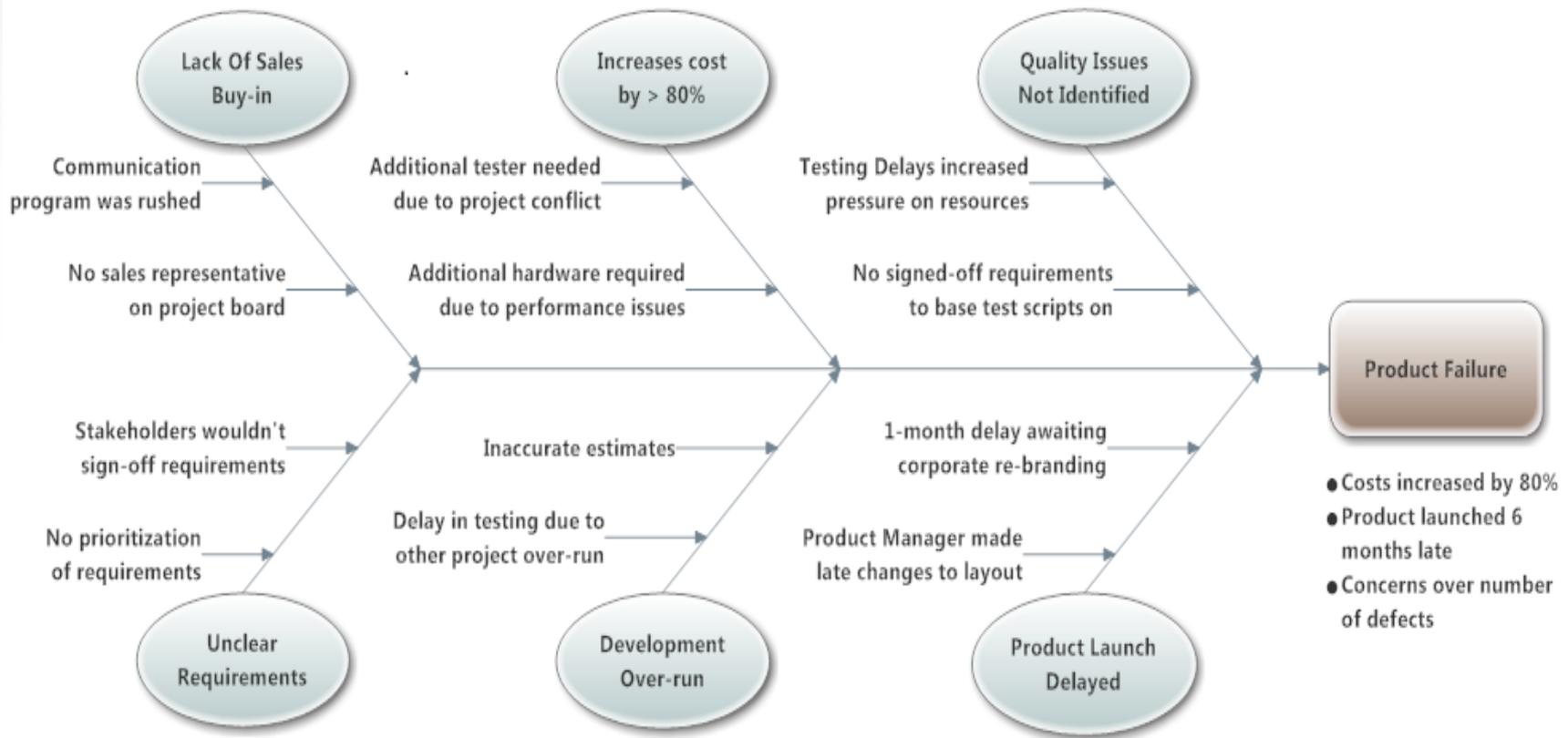
- two different ways to create
 - *Dispersion analysis*
 - *Cause enumeration*

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

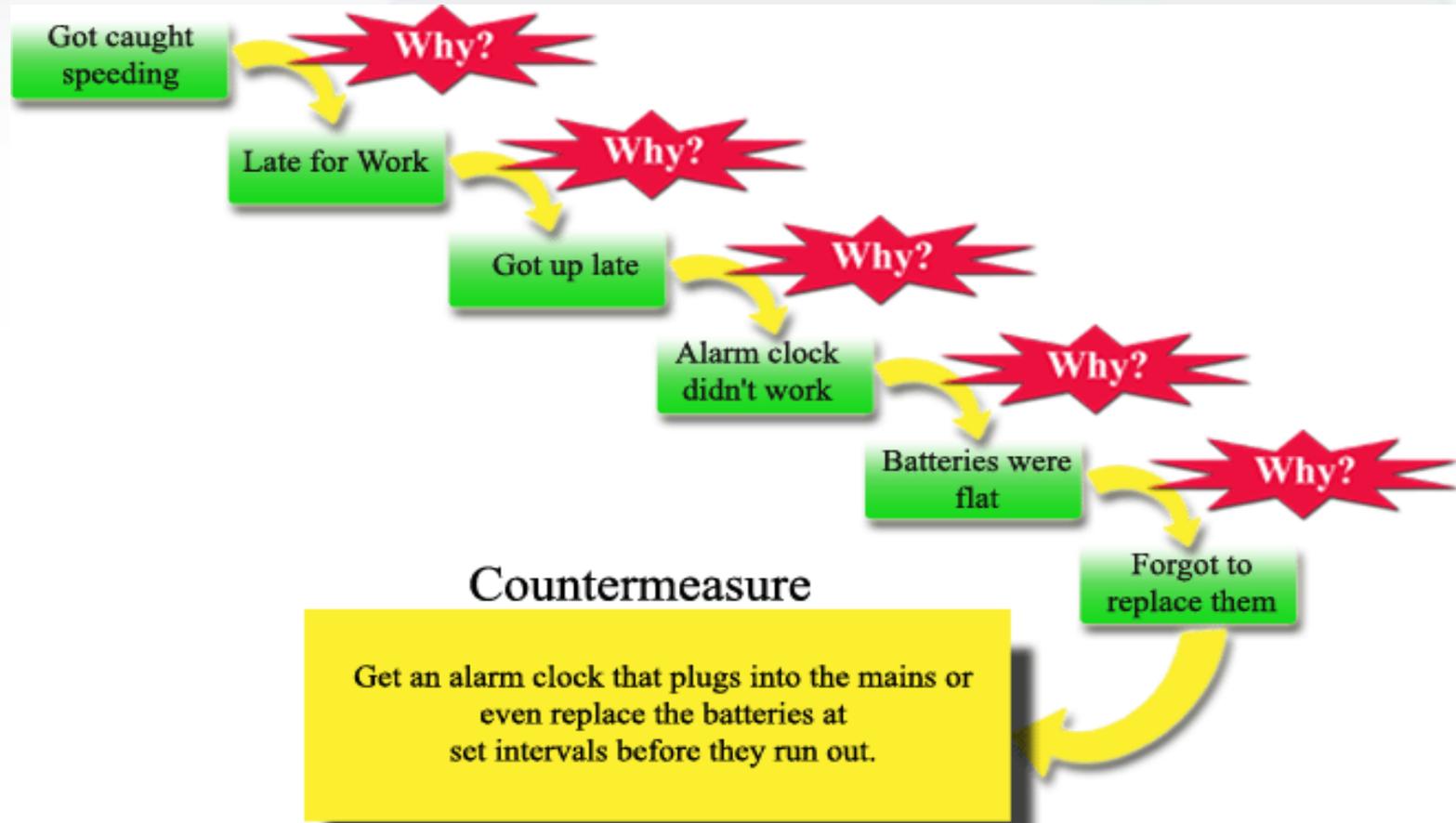
A large, light blue, semi-transparent graphic of the letters '5W' is centered on the page. The '5' is on the left and the 'W' is on the right, both rendered in a bold, rounded, sans-serif font. The background is a light, neutral color.

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

Five Whys - Template

Root Cause Analysis Template

| | Date: | Area: | Product/Pro | |
|--|-------|-------|-------------|---|
| <p>1</p> <p>Use this route to specify the nonconformity that is being investigated.</p> <p>Why? → []</p> | | | | <p>3</p> <p>Root Causes</p> |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Use this route to investigate why the problem wasn't detected</p> <p>Why? → []</p> | | | | <p>4</p> <p>Corrective Action & Responsibility</p> |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Use this route to investigate the root cause of the system.</p> <p>Why? → []</p> | | | | <p>5</p> <p>Date</p> |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |
| <p>Therefore ← []</p> <p>Why? → []</p> | | | | |

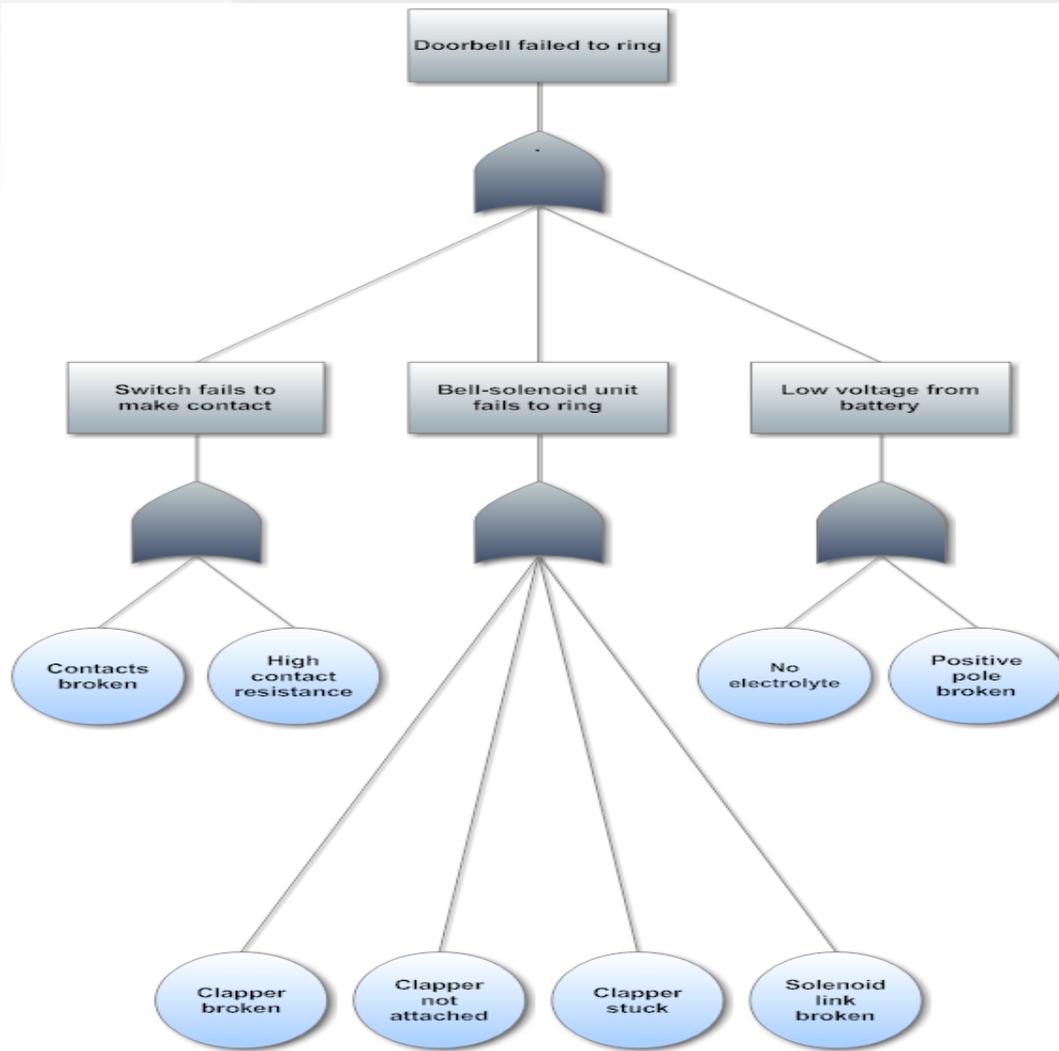
EXERCISE

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

