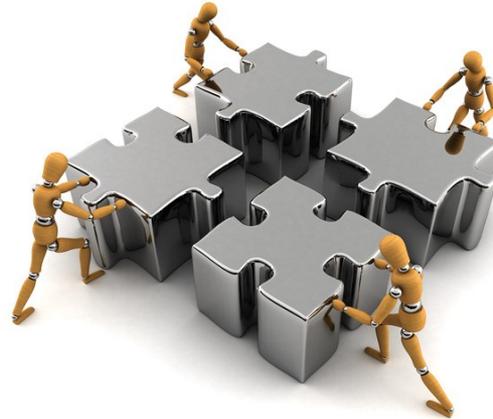


PROBLEM SOLVING ROOT CAUSE ANALYSIS



NE Indiana Lean Network
NE Indiana Innovation Center
March 17, 2010

PURDUE UNIVERSITY
MANUFACTURING EXTENSION
PARTNERSHIP

Bill Paolucci

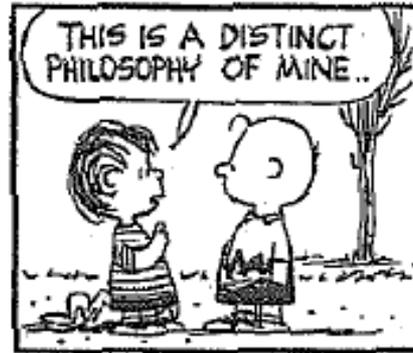
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If This Is You!

PEANUTS



Charles M. Schulz

You are in the Right Place



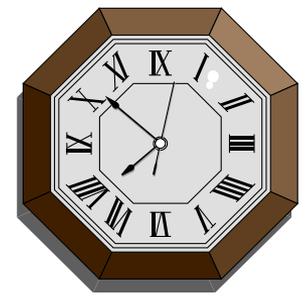
Today's Objective

- Introduce Problem Solving Basics
- Discuss developing a Problem-Solving attitude
- Look at Problem Solving Elements
- Discuss the advantages of a structured team-based problem solving process.

Problem Solving is a Key Activity in Lean Manufacturing



Lean System



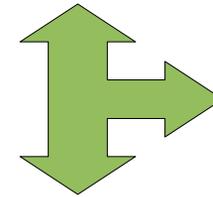
- Lean introduces a new concept of using time
 - Traditional - We think there isn't time to do things right
 - Lean - There is no time to do things over!!
- We cannot afford to wait for someone to solve a problem.
- We must act to solve the problem ourselves now.
- We need structure and discipline to solve a problem and execute permanent countermeasures.



What Is a Problem?

Desired State

(What you want to happen - standard)



Actual Situation

(What is currently happening)

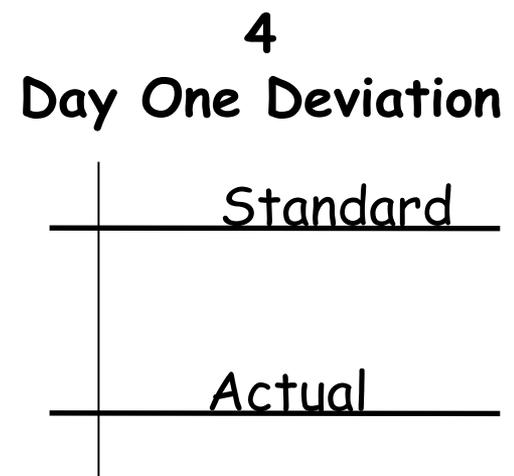
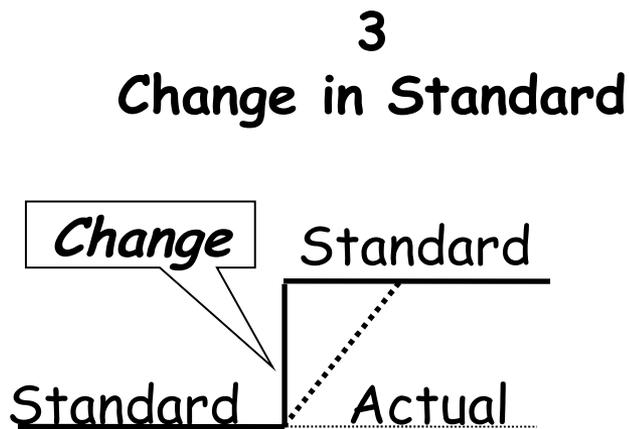
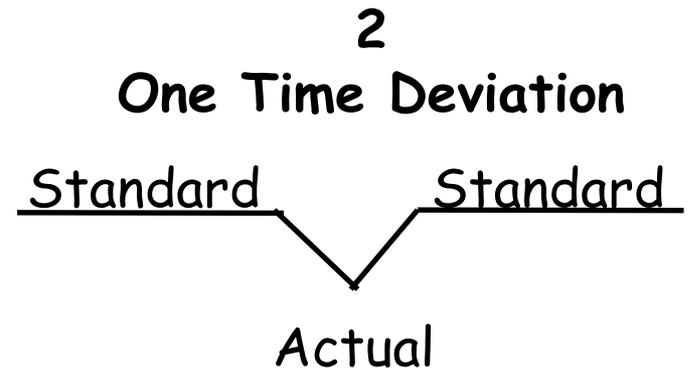
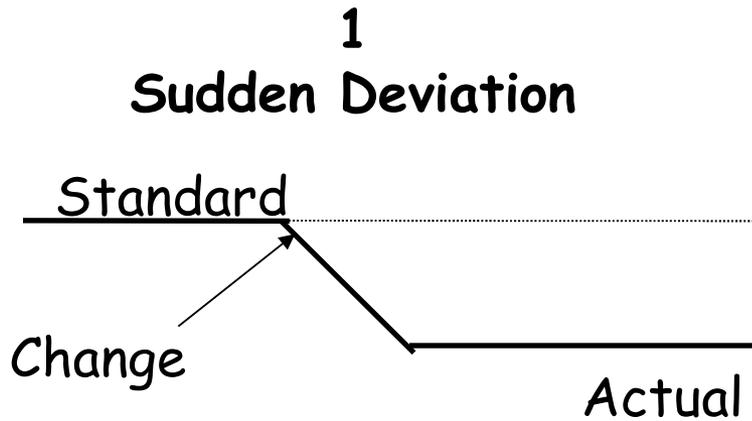


A Problem is a gap between the actual situation and the desired state.

A problem is not a problem until defined with data
"In God We Trust, everyone else bring data"
Dr. E. Deming



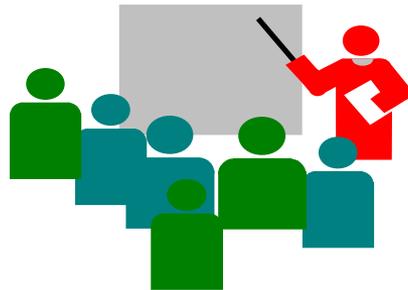
Different Problem Styles



All 4 styles have a problem or a deviation between what should be happening and what actually happens.

Problem Solving

Process Overview





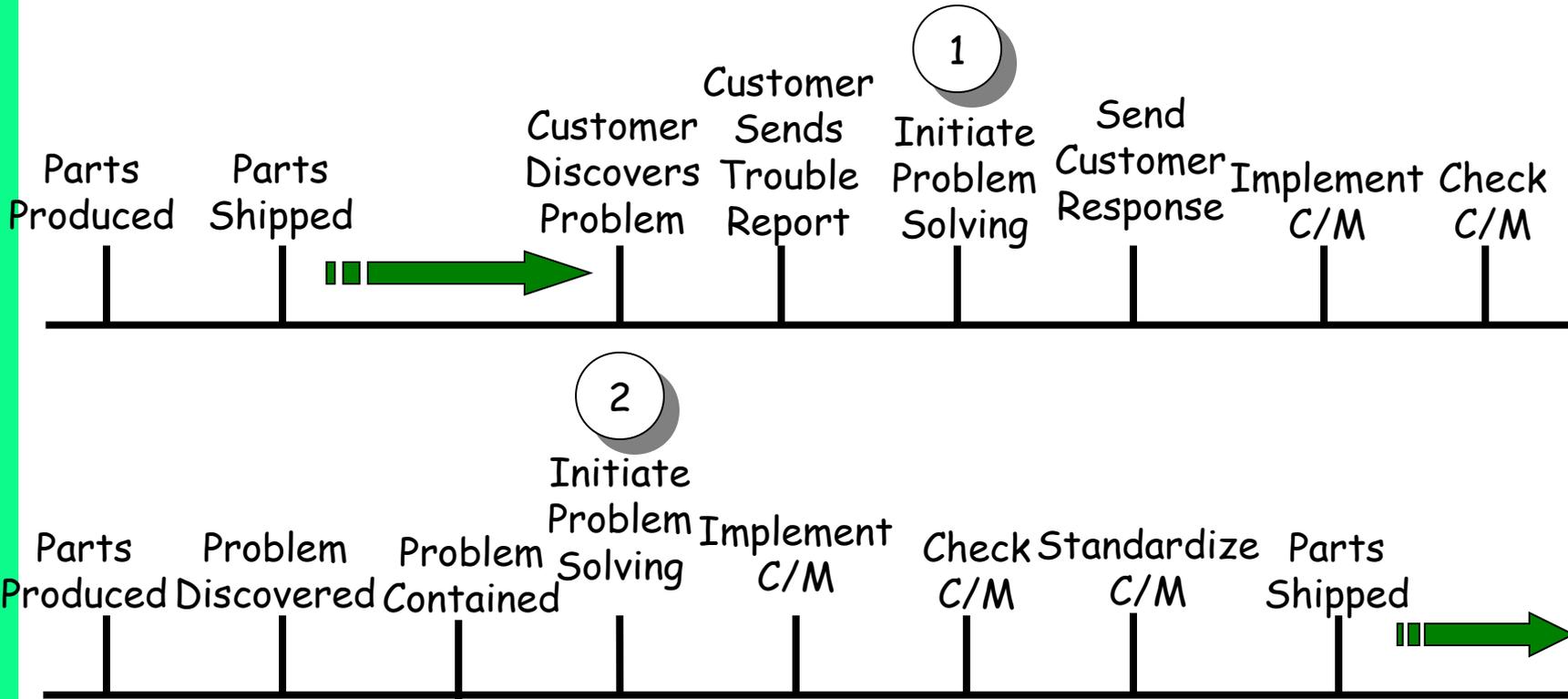
Why Use Problem Solving?

- “No Problem” is a problem
 - Problems are opportunities to learn
 - Hiding problems undermines the organization
 - The goal is to uncover problems and turn them into improvement opportunities
- Shift the focus away from each other and toward the white board and the data.
 - Stress are reduced
 - People like having the marker in their hands



Problem Solving

Where Does Your Problem Solving Start?



Problem Solving should be a Proactive Activity, not Reactive.



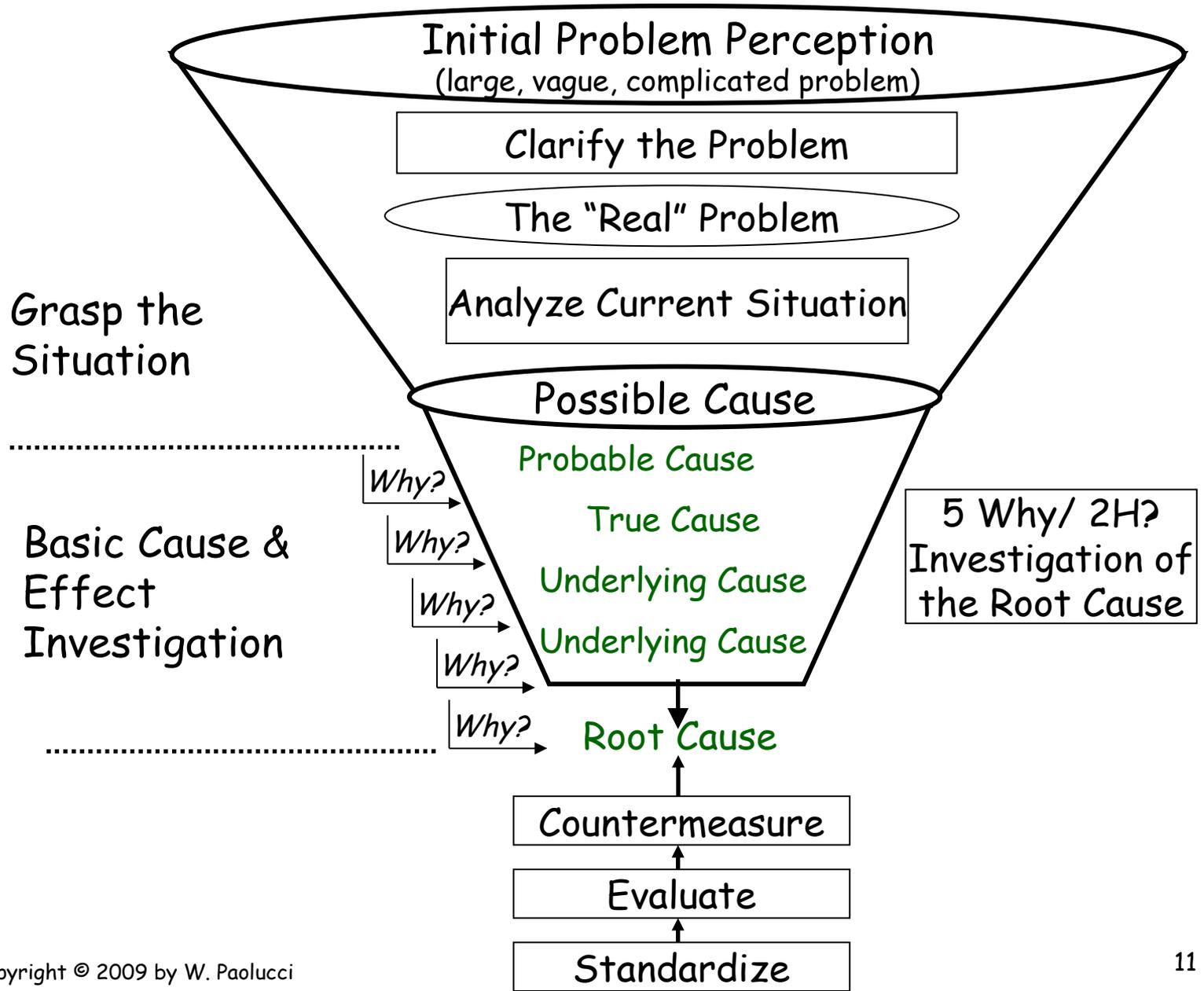
Reactive Problem Solving



Spin-A-Cause - the fastest root cause analysis tool in the world! Just a single spin and you have the root cause and the corrective action for any incident.

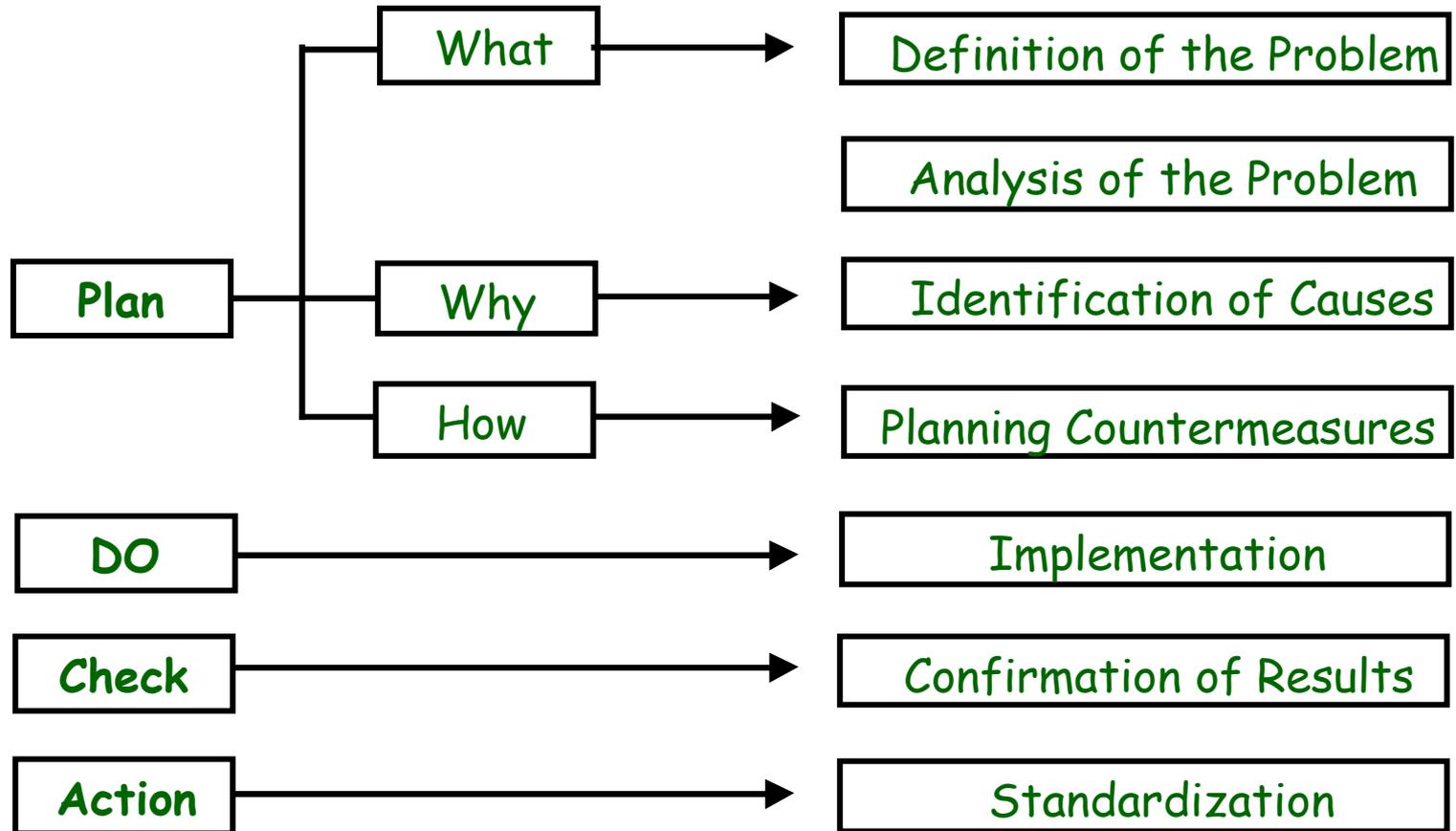


Narrowing Process





PDCA Problem Solving Cycle



PDCA can't stop until problem is permanently fixed.

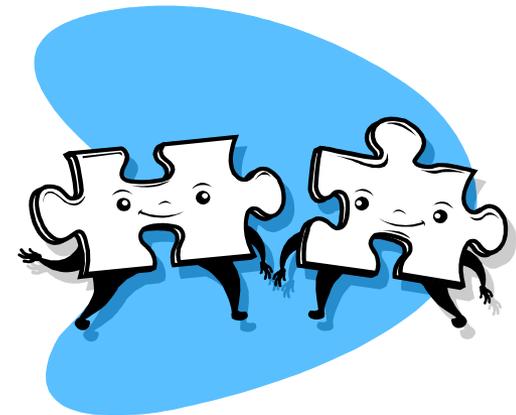
Basic Problem Solving Stages

- Expose the Problem



- Analyze the Problem

- Solve the Problem





Expose The Problem

Identifying the Issue At Hand

- Everyone uses the same data to avoid disagreement



- Avoid fire fighting by carefully defining and discovering details creating the unacceptable situation.

Develop a Team



- Allow you to make needed changes in a short time.
- Focus on what is best for the entire group, not just an individual
- Provide benefits for the individual and the organization.



Types of Teams

- **Leadership Team**
 - Determine the company's vision and, from there, set goals
- **Project Teams**
 - Formed to work on a specific problem and disbanded
- **Self-Directed Work Teams**
 - Include all members who work in a specific department on a specific shift
 - Are responsible for an entire work process
 - Are permanent teams who have control and responsibility for all aspects of their work area

Effective Problem-Solving Uses Self-Directed Teams

HINT: Find someone outside your area in a different discipline for another point of view

Define and Clarify the Problem



- Problem Solving always begins with a well written problem statement.
- You want to remove any confusion and ambiguity about the issue by describing in detail exactly what occurred.
- This keeps your team focused precisely on your issue, and stops any "scope creep".
- Your problem statement should **never** detail a cause for the issue.



Poorly Written Examples

- The widget is too long.
- There are too many errors in our reports.
- Our delivery time is horrible.



Better Examples

- The last 10 production runs show the widget measured an average of 41cm which exceeds the customer requirement of 38cm +/- 2cm.
 - Defines what, when the issue occurs, and the requirement
- The past 2 months the quality reports contain more than 2 errors on average, greater than the 0 errors expected.
 - Defines what, when, how many, and the expected results
- On-Time Delivery to Customer X has been only 92% for the last 4 months, less than the required 98.5%.
 - Defines where the issue occurs, status, target, and time frame





Well Written Problem Statement

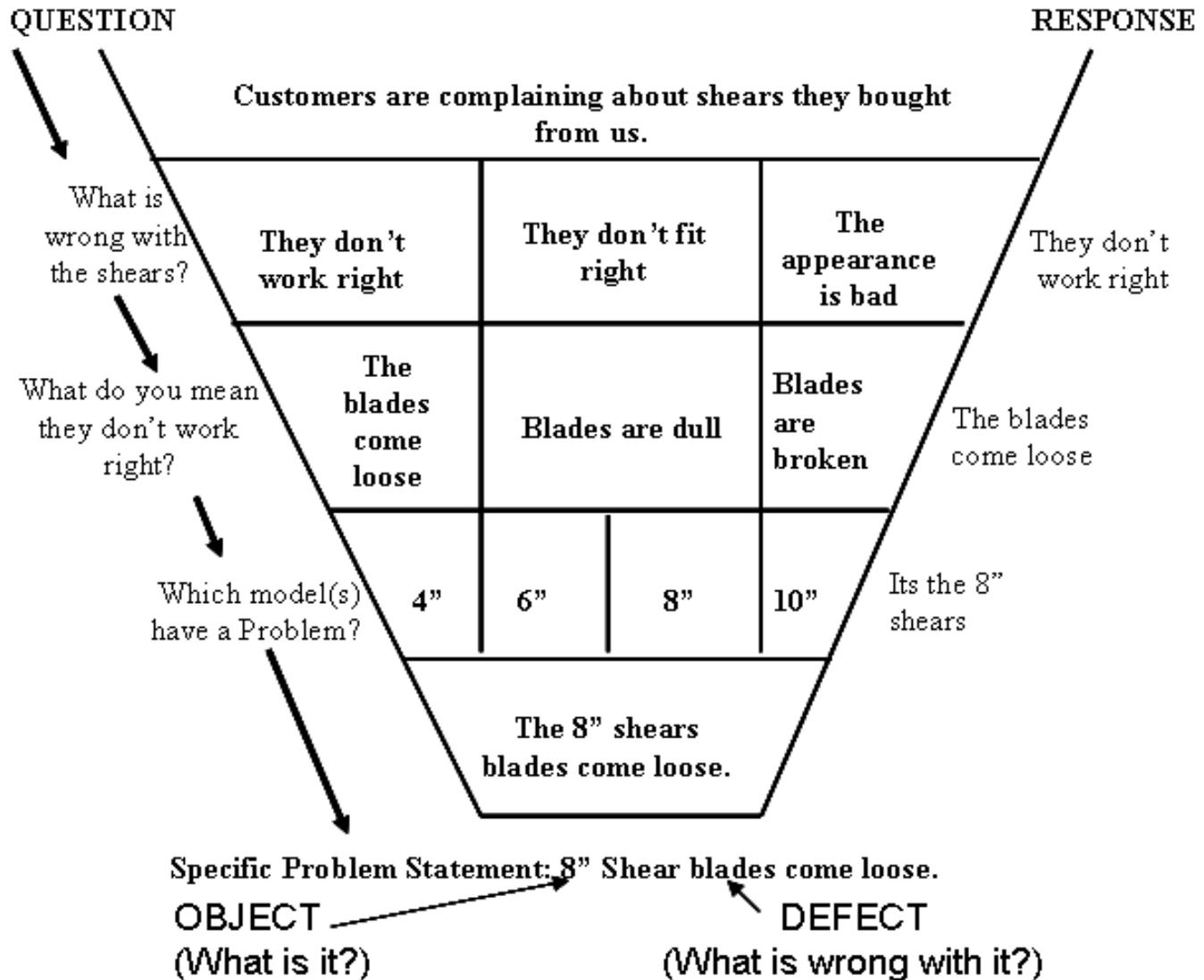
Ask Questions in 7 Areas

- **Who**
 - Who found the problem?
- **What**
 - What part has the problem?
 - What is wrong with it?
- **When**
 - When was the problem first found?
 - When has the problem recurred?
- **Where**
 - Where were the problems first observed?
- **Why**
 - Why is it a problem?
- **How**
 - How was the problem found?
- **How Many**
 - How many parts have the problem?
 - How many defects on each object?



Well Written Problem Statement

Use the Narrowing Process to one specific problem
Only One Object, Only One Defect



Study the Current Situation



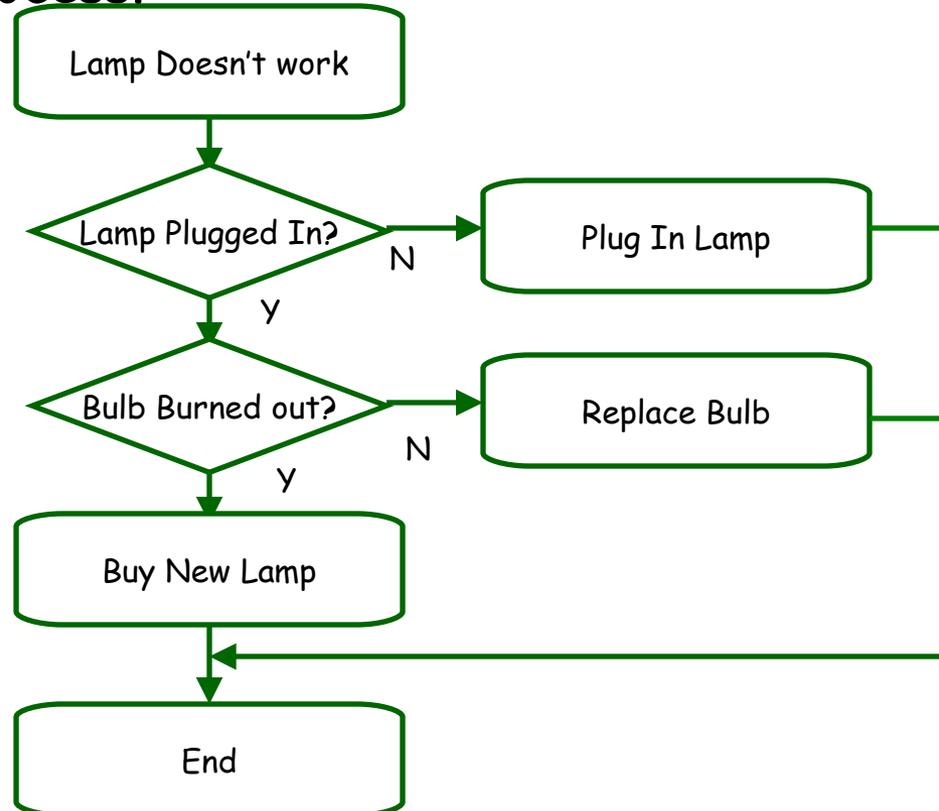
- ❑ Use all available sources of information such as flowcharts, 5W/2H, and check sheet data to clarify the problem
- ❑ Be as specific as possible, indicate if you need to collect more data.
- ❑ Answer specific questions in 4 areas

| | |
|--------|----------|
| What | Identity |
| Where | Location |
| When | Timing |
| Extent | Size |



Process Flowchart

A **flowchart** is a diagram, that represents a process, showing the steps as boxes of various kinds, and their order by connecting these with arrows. Flowcharts are used in analyzing and documenting a process.



A flowchart is the first task in data collection. A process flow diagram is used to obtain agreement and clarity on the process steps by team members.



Collecting Data

- Agree on the parameters for collecting data
- Decide who will collect the data, and how often
 - Data collectors need process knowledge and time to collect
 - If they are not team members, educate them on your project
- Design a check sheet that is clear and easy to use
- Collect data consistently and accurately according to your plan.
- Chart the data to visually find trends

If reliable data is available, use it! If you don't have confidence in the data create check sheets to collect current data.



Checkpoint - At This point you should:

- Tell exactly what part/person/object or machine has the problem.
- Describe exactly what is the specific defect.
- Explain in detail, actual, clear, specific information about the problem.
- Illustrate how you found the problem (charts / graphs).



Analyze The Problem

Focusing on the Problem is the Problem

- If you want to learn a new skill where is your focus?
- Focus on continuous improvement (PDCA) - one step at a time.
- Digging deeply to just know what went wrong, misses the opportunity to solve the problem.



Dig deeply to solve the problem.

Root Cause Analysis



A non-conformance can occur in three areas, and is applied independently to each one.

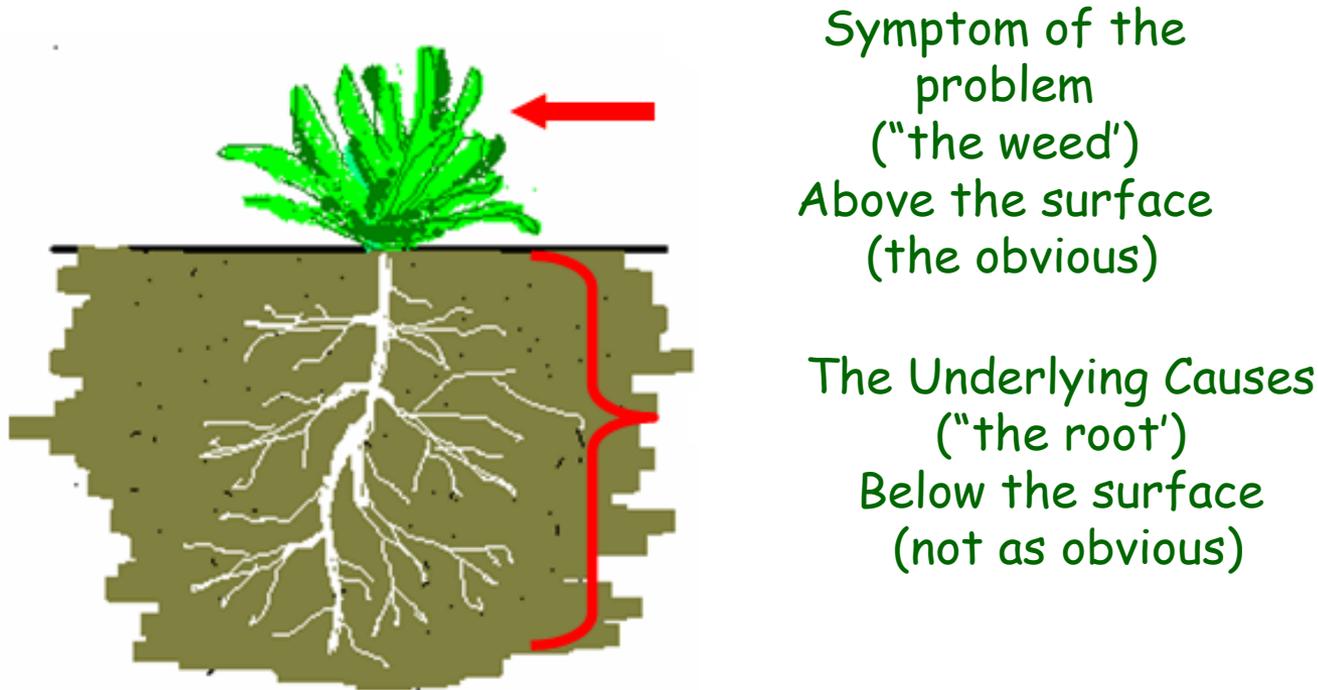
Current Non-conforming Situation
Detection
Systemic



Root Cause Analysis

Root cause analysis (RCA) is a technique for finding and correcting the most important reasons for problems.

- **RCA** is not troubleshooting
- **RCA** is directed at underlying issues, and eventually the root cause.



The root in Root Cause Analysis refers to the underlying causes, not the one obvious symptom

Different Methods For Developing Root Cause(s)

- Brainstorming

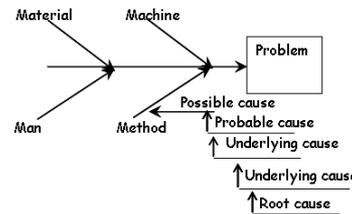


Always

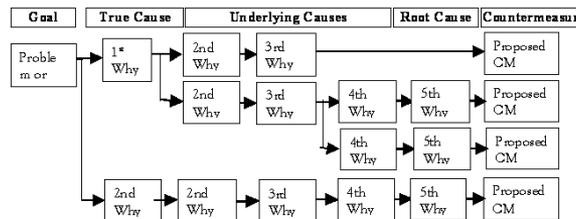
- 5WHYs

Simple Problems

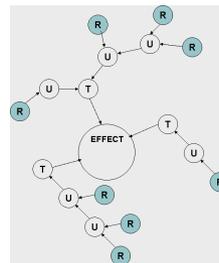
- Fishbone Diagram



- Why Tree



- Mind Mapping



Pick whichever you feel works the best



Cause & Effect Diagram

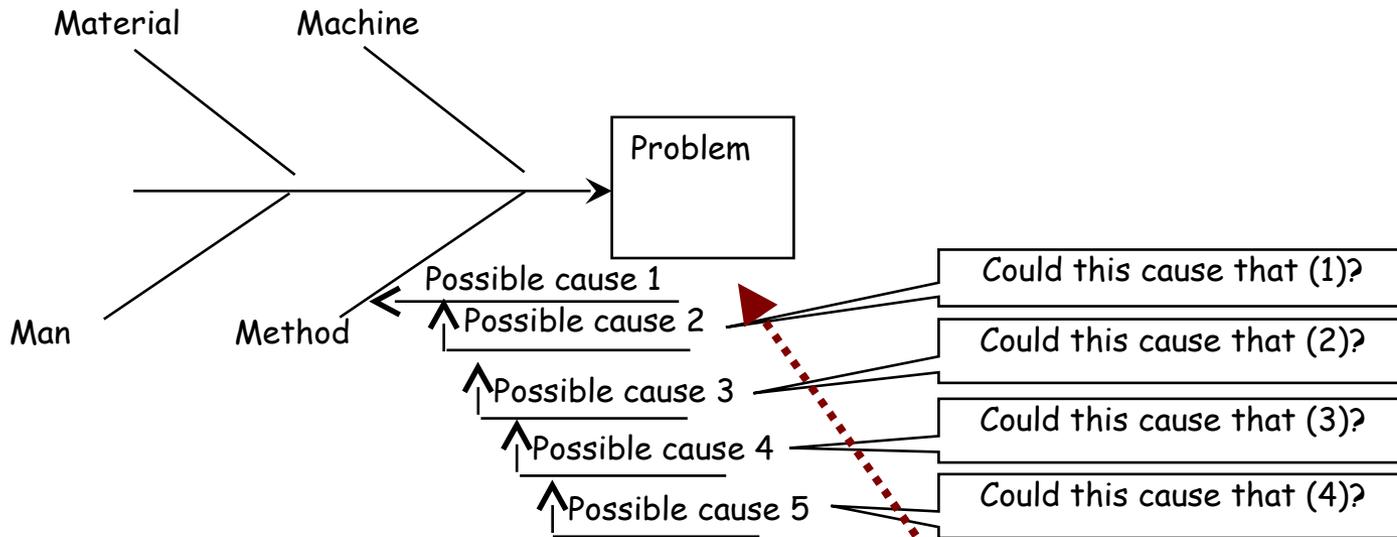
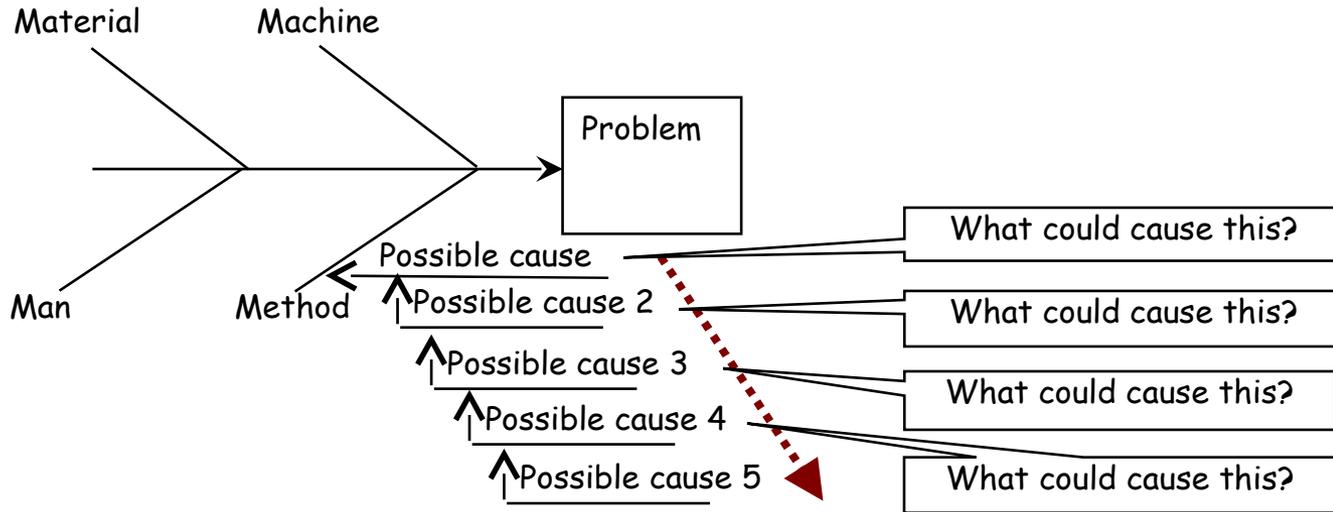
A C&E Diagram helps identify, explore and display in increasing detail, all the possible causes related to a problem or condition in order to discover its root cause(s).

Types of Causes:

- **Possible** - Found after brainstorming, any and all causes to be considered.
 - **Probable** - After initial sifting of possible causes the ones transferred to the analysis chart.
 - **True** - When investigation in to probable causes proves correct. (1st Why is answered).
 - **Underlying** - Subsequent answers to Why? Why?
 - **Root** - Last underlying cause that can be countermeasured.



Cause & Effect Diagram (Fishbone)





Cause & Effect Diagrams

A Cause and Effect diagram considers all production variables and shows the step-by-step creation of a problem, much like a process diagram shows the steps of a process.

Production System Variables (4Ms)

1. **Material** - no defects or shortages
2. **Machine** - no breakdowns, defects, or unplanned stoppages
3. **Man** - good work habits, necessary skills, punctuality, and no unscheduled absenteeism
4. **Method** - Standardized processes, maintenance, and management



Basic Elements of Production System Variables

- **Material**

- Defective raw material
- Wrong type for job
- Lack of raw material

- **Machine**

- Incorrect tool selection
- Poor maintenance or design
- Poor equipment or tool placement
- Defective equipment or tool

- **Man**

- No or poor management involvement
- Inattention to task
- Task hazards not guarded properly
- Other (horseplay, inattention....)
- Stress demands

- **Method**

- No or poor procedures
- Practices are not the same as written procedures
- Poor communication

- **Management**

- Training or education lacking
- Poor employee involvement
- Poor recognition of hazard
- Previously identified hazards were not eliminated

- **Mother Earth (Environment)**

- Orderly workplace
- Job design or layout of work
- Surfaces poorly maintained
- Physical demands of the task
- Forces of nature

- **Measurement**

- Uncalibrated measurement tools
- Inaccurate measurements
- Insufficient measurement data



5 Whys

- The 5 Whys is a question-asking method used to explore the cause/effect relationships underlying a particular problem.
- The real key is to avoid assumptions and go upstream in increments (repeatedly asking "Why" 5 times) from the effect through the underlying causes peeling away symptoms and getting to the root cause.

- **Benefits Of The 5 Whys**

- Quickly identify the root cause of a problem.
- Determine the relationship between different root causes.
- Learned easily and doesn't require statistical analysis to be used.

- **When Is 5 Whys Most Useful?**

- When problems involve human factors or interactions.
- In all types of business situations whether solving a lean manufacturing or for any other business problem.



How To Complete The 5 Whys

1. Write down the specific problem.

Writing the issue helps you formalize the problem and describe it completely. It also helps a team focus on the same problem.

1. Ask Why the problem happens and write the answer under the problem.

If the answer you provided doesn't identify the root cause of the problem, ask Why again and write that answer down.

If the answer you provided is not in your control, don't write the answer down, go back and ask the same Why again.

1. Keep asking Why until the team is in agreement that the problem's root cause is identified.

This may take fewer or more times than five Whys.



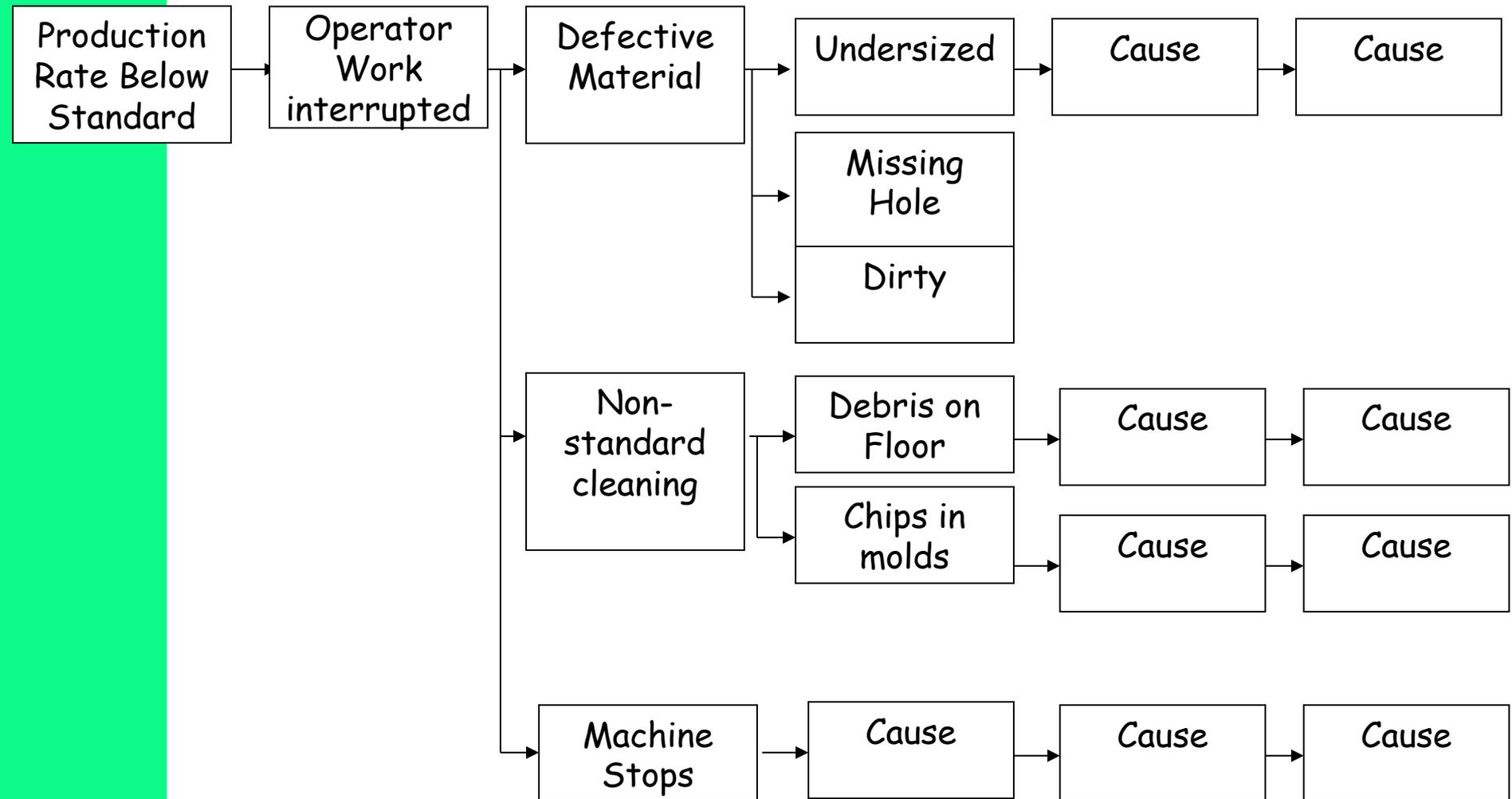
5Why Example

Problem Statement: You are on your way home from work and your car stops in the middle of the road.

1. **Why** did your car stop?
 - Because it ran out of gas.
2. **Why** did it run out of gas?
 - Because I didn't buy any gas on my way to work.
3. **Why** didn't you buy any gas this morning?
 - Because I didn't have any money.
4. **Why** didn't you have any money?
 - Because I lost it all last night in a poker game.
4. **Why** did you lose your money in last night's poker game?
 - Because I'm not very good at "bluffing" when I don't have a good hand.



5Why Example



Select & Prioritize Countermeasures



Any Action Taken To Correct
the Root Cause Should
Ensure The Undesired Event
or Problem Will Not Re-occur

How many times do we solve the same
problem over again....



Countermeasures

- Actions which keep problems “in control”
- **Hard Countermeasure (Can't Make)**
 - Reduces the probability of producing a defect to zero.
 - The possibility of a faulty action is eliminated
 - Designed into the process permanently
- **Soft Countermeasure (Can't Cycle, Accept or Pass)**
 - Signals the operator to stop the process because a faulty action occurred
 - Prevents further processing, but allows a defect to be produced
 - Must be used constantly to avoid the problem.
 - Soft countermeasures cannot be removed until an error-proofing method is designed to obsolete the countermeasure.



Countermeasure Selection

Look at both short-term and long-term countermeasures

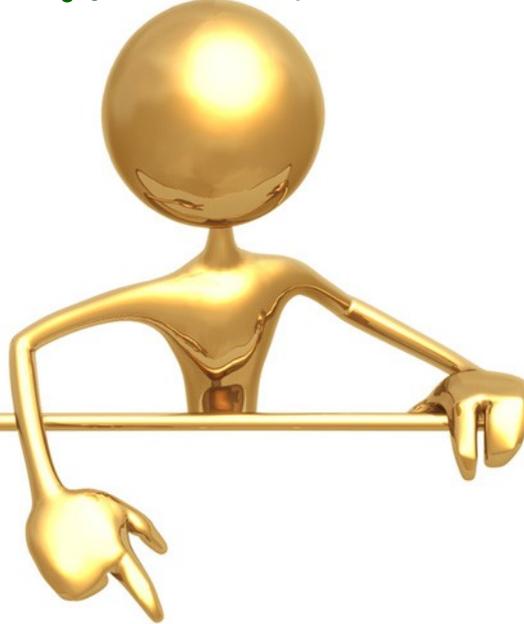
- Short-term
 - What would reduce the problem immediately?
 - Implement while developing long-term countermeasures
- Long-Term
 - Does it really achieve your goal?
 - Will it prevent recurrence of the problem?
- Remove the short-term countermeasures as soon as possible.



Countermeasure Selection

- Include all countermeasures you are planning to implement
- Countermeasure selection
 - Use decision matrix to select the most effective countermeasures
 - Don't overdo the solution, countermeasures do cost money.
 - Make sure the countermeasure is in your control to implement.
- Know who will be responsible for implementation.
- It's often easier to break large actions into bite-sized tasks delegated to employees who can be assigned responsibilities, resources, due dates, and reviews.

Countermeasure Planning



Planning Ensure Success

- Communicate early and often
- Stay focused on the causes
- Get creative
- Make change happen

The better the plan, the more likely the action is to be successful.



Problem Solving Observation

Expert trouble-shooters develop the ability to know what information is missing when solving problems.

The novice takes the information that is given them and tries to solve the problem.



Solve The Problem

Use Experiences of Everyone to Develop a Solution

- Operators are a wealth of knowledge
- Check other departments and other plants in the company.
- Use the Proactive Approach by using mistake proofing.

Use all Available Resources, think about eliminating the problem completely.

Countermeasure Testing & Verification



Define necessary actions

- List actions required
- Sequence of actions required
- Specify who will do what, when, and where
- Include specific instructions for non-team members to ensure they understand the objective

When Testing countermeasures, effective implementation cannot be assumed.



Common Verification Points

- Did the actions address problem causes, instead of just symptoms?
 - The single biggest reason for problem-solving failure is action on symptoms instead of true causes.
- Are the actions fully implemented?
 - You can't verify effectiveness until actions have been fully carried out.
- Are products or outcomes improved?
 - What do records and data indicate, hearsay and verbal affirmations can't be used to prove that products have been improved.
- What is the customer's perception of an improvement?
 - If customers have not noticed an improvement.
- Has the problem reoccurred?
 - If the problem continues to occur at the same level as before, then the corrective action is not effective.

Countermeasure Standardization



- Have procedures been revised or developed?
- Are employees aware of and knowledgeable about the changes?
- Has measurement or monitoring been established?
- Apply error proofing so that countermeasures may be removed.



Errors are Inevitable

- Errors are inevitable, a part of human nature.
- Understanding human limits is essential.
- These limits include:
 - **Vision:** People vary in ability to distinguish details, colors or adjust vision to lighting.
 - **Hearing:** Individual upper and lower thresholds of hearing change when background noise is added.
 - **Repetition Ability:** Muscular efficiency and mental tracking decrease as rates of repetition increase.

So How Do We Prevent Human Errors
From Becoming Defects?



Poka-Yoke (Error-Proofing)

- In a lean production system, Poka-Yoke is a process improvement designed to prevent a specific defect from occurring. Poka-Yoke:
 - Prevents personal injury
 - Promotes job safety
 - Eliminates faulty products
 - Prevents machine damage.
- Sometimes known as, Mistake-proofing or Fool-proofing (Baka-yoke).

"Quality comes not from inspection, but from improvement of the process." W. Edwards Deming

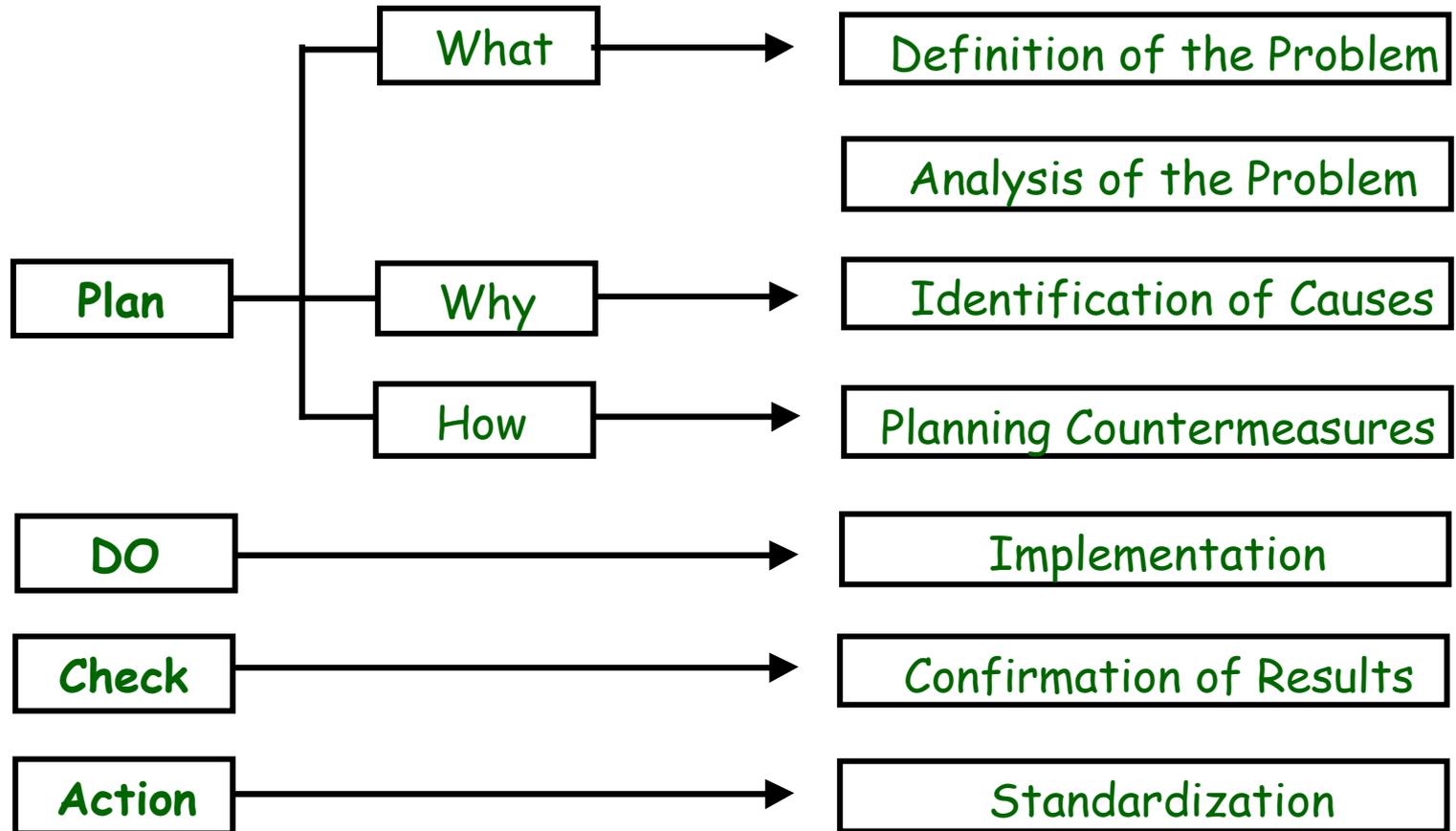
Establishing the Process



- Follow PDCA
- Select Quality Tools
- Develop a Problem Solving Process
- Design Supporting Tools
- Educate Everyone
- Make it Part of your Daily Routine



PDCA Problem Solving Cycle



PDCA can't stop until problem is permanently fixed.



Basic Quality Tools

Brain Storming

Checksheets

Pareto Diagrams

Histogram (and Bar Chart)

Cause & Effect Diagram

Flow Diagrams and Process Maps

Run (Trend) Chart

Control Chart



Root Cause Analysis Techniques

Which One To Use?

5 WHYS

Barrier analysis

Change Analysis

Bayesian inference

Pareto Analysis

Casual Factor Tree analysis

Kepner Tregoe

Fault Tree Analysis

Ishikawa Diagram

Current Reality Tree

Failure Mode and Effect Analysis (FMEA)

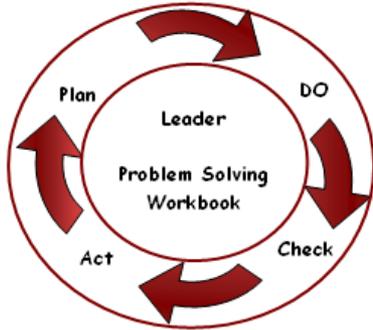


Four Improvement Strategies

| PDCA | Nisco Problem Solving Steps | 8D | 5P | TWI |
|--------------|--|---------------------------------------|-------------------------------|--|
| | 1. Develop a Team 2. Define & Clarify the Problem 3. Analyze the Current Situation | 1. Form a Team | 1. Problem Definition | 1. Find and Clarify the Problem |
| PLAN | 4. Root Cause Analysis 5. Select & Prioritization CMs 6. Countermeasure Planning | 2. Define Problem | 2. Identify Root Cause | 2. Find the Root Causes 3. Identify and implement countermeasures |
| | | 3. Containment | | |
| DO | 7. Countermeasure Testing | 4. Root Cause 5. Corrective Action | 3. Corrective Countermeasures | 3. (cont'd) |
| CHECK | 8. Countermeasure Verification | 6. Prevention 7. Verify | 4. Confirm Countermeasures | 4. Confirm and follow up |
| ACT | 9. Countermeasure Standardization | | 5. Feedback/Feed Forward | 4. (cont'd) |
| | 10. Planned Goal vs. Actual | 8. Congratulate | | |

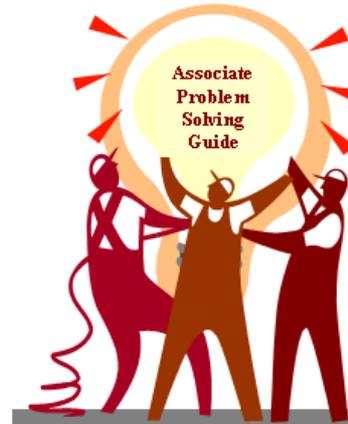


Develop Tools



| | |
|---------------|--|
| Project Name: | |
| Team Leader: | |
| Date Open: | |

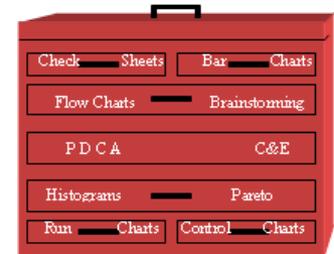
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| Author: William J. Paolucci | Date: 01/25/2010 | Page 1 of 49 |



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|-----------------|--|
| Associate Name: | |
| Team Name: | |

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| Title: Problem Solving Workbook | Doc. No.: | Revision: NEW |
| Author: William J. Paolucci | Date: 01/28/2010 | Page 1 of 27 |

QUALITY TOOL BOX



A PRACTICAL GUIDE FOR QUALITY TOOLS USED IN IMPLEMENTING CONTINUOUS IMPROVEMENT ACTIVITIES

| | | |
|-----------------------------|------------------|---------------|
| Title: Quality Tool Box | Doc. No.: | Revision: NEW |
| Author: William J. Paolucci | Date: 01/26/2010 | Page 1 of 31 |



Educate

- Develop different levels
 - Manager
 - Leader
 - Participant (Operator)
- Remember to hone education to learning styles of each audience
- Implement education continuously



Proactive- Requires A Change in Thinking

Concentrate on the Facts, Not the Who of the Problem

Promotes
Problem Solving

Full Acceptance of Responsibility

Partial Acceptance of Responsibility

Problem Solving
May happen

Someone Else is Responsible to Fix it.

We have No Time or Money to Solve it.

No Solution. We have always done it this way.

Blame Others for It

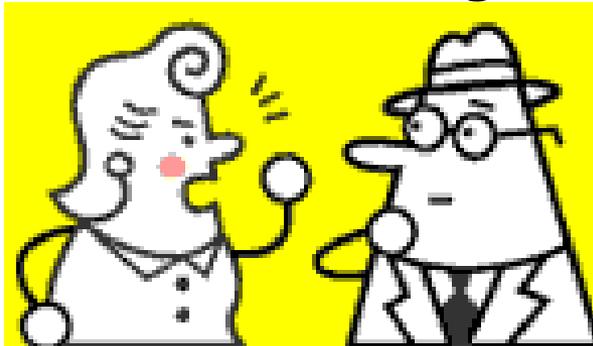
Deny the Problem Exists

Ignore the Problems



Make it Part of your Daily Routine

- Get in the habit of asking "Why?" several times whenever you discuss a problem
- Setup management review to encourage mentoring while using the process and extending the learning
- Use it at home (gently!!)





NISCO

NISHIKAWA STANDARD COMPANY LLC

William J. Paolucci

Director of Material Management

ウィリアム J. ポルーチ

bpaulucci@niscoseals.com

324 Morrow Street
Topeka, IN 46571

Telephone: (260) 593-2156 Ext. 672

Telefax: (260) 593-3201

Cell: (260) 499-0317

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