

Root Cause Analysis and Problem Solving

(Aligned with IAQG 9136 draft)

Date: April 2014

www.iaqg.org/scmh Section 7.4

Objective

Root cause analysis and problem Solving:

Propose methodology to improve the way escapes and problems are managed (including communication between all actors - engineering, MRB, supplier, customer, etc...) to reduce their impacts, contain them as far upstream as possible and prevent recurrence (ensure that the right measures are taken at the right location, at the right time and by the right persons).

Rational of the Objective

- Objective of continuous improvement is to reduce number of issues (undesirable conditions, defects and failures) but also to minimize their impact on quality, delivery performance and costs.
- Several big issues originate with small problems that were discovered but were never resolved due to incorrect analysis and/or ineffective actions.
- Often, organizations and their suppliers do not deliver correct Root Cause Analysis and Problem Solving results because:
 - No clear criteria exist about what makes an acceptable corrective action plan (people are satisfied when they no longer receive defective parts and stop)
 - People continue to accept bad answers (even if they say they will not, reality of life makes them accepting)
 - People (internal and external) do not have the Root Cause Analysis culture, they don't know the process or are not effectively trained
- Cultural change required to overcome the situation

Brainstorming

Benefits of effective Corrective Action process (1/2)

- Sustainable performance (product conformity, on time delivery, etc...)
- Reduce cost of quality (reduces costs by eliminating wastes and unnecessary efforts)
- Protect internal and customer operations
- Solving and preventing problems on similar parts, processes, lines, etc
- Really understand the issue and identify corrective action at first time
- Ensures right measures are taken at the right location and right time
- Ensure stable processes
- Don't repeat failures
- Customer satisfaction
- Supplier reputation
- Objective evidence for evaluation of corrective action effectiveness

Brainstorming

Benefits of effective Corrective Action process (2/2)

- Compliance with international standards and aviation authorities requirements
- Improved communication between all stakeholders of the supply chain
- Motivate teams and recognise efforts
- Continual improvement
- Harmonise corrective action process between all stakeholders (suppliers, customer, etc)
- Allow use of unique IT system structure (same fields, definition, etc...) in the future
- Lessons learned captured and used
- Beneficial to the whole organization (improve overall business results)
- reduce impact of problems to the minimum and contain them as upstream as possible
- Reduce time to get a fix (avoid diverting staff from key roles and objectives)

Brainstorming

Risks and impact of not having an effective corrective action process (1/3)

- Believing you have fixed an issue but not having done it.
- Stopping investigation at first identified cause
- Believing one problem has only one cause, so one fix
- All non-conformances cost money, which reduces investment, money available for pay rises, potential to retain business
- Fix the issue on one product or in one area and repeating similar mistake somewhere else later, especially for new programs
- Look for guilty, not for solutions
- Used for blaming or transferring responsibility
- Blame systematically on Quality, not looking for true responsibilities

Brainstorming

Risks and impact of not having an effective corrective action process (2/3)

- Repeating mistakes
- Permanently working in fire fighting mode
- Not enough time for analysis
- Dealing only with same big problems and never dealing with the other systemic ones (no time to fix them)
- Going from one crisis to another
- Negative customer perception
- Loss of business
- Loss of international approvals
- Hidden costs
- Loosing opportunity for improvement
- Not attacking problems by adequate priority order (no risk based approach)

Brainstorming

Risks and impact of not having an effective corrective action process (3/3)

- Not attacking problems in a systematic way
- inability to protect your customer's business
- Letting small problems develop until they become critical
- Spend valuable resources and substantial investment applying inappropriate methodology
- Waste more time to attempt to demonstrate there is no problem than to understand and fix it
- Loss of motivation due to increase of mistakes which leads to even more mistakes
- Not capitalising on experience (not updated instructions, paperwork, drawings, etc)

Brainstorming

Key factors of success

- Immediate containment “Stop the bleeding”
- Build team and assign responsibilities
- Identify common goals
- Identify action owners and time scales
- Identify external measures (actions)
- Protect the operations (e.g. over production)
- Contain the situation “Build the wall higher” (e.g. over inspection)
- Map process
- Identify internal measures (actions)
- Measure current performance
- Identify and prioritise key problems
- Identify root causes
- Communicate (includes notification to customer)
- Identify solutions
- Implement solutions
- Verify effectiveness of the solutions
- Manage change effects
- Measure new performance
- Review performance
- Assess success
- Document changes
- Capture learning (keep lessons learned register)
- Recognise team and celebrate success

Top Management must be committed to the corrective action process to ensure effectiveness

3 Problem Solution Types

- Reactive mode
Solving the abnormality that has occurred, gathering and analyzing data aims to provide a customer protection and countermeasure.
- Pro-active mode:
Analyzing failures and looking for improvements.
- Preventive mode:
Putting in place solutions before undesirable condition, defect or failure occurs.

Effective root cause analysis: A cultural change

Reacting to an Event Traditional solutions

- Fire Fighting
- Quick Fix
- Not taking enough time for analysis
- Going from one crisis to another
- Look for the guilty party. "Who did that?"
- Generate laundry list of solutions to firefight the symptoms.
- Narrow focus results in sub-optimization of system.
- Focus on performance metrics (e.g. sales and profits) and hope processes improve.

Systems Thinking Systemic solutions

- Many factors making up a complex situation
- Fully understanding the problem and then addressing the systemic root cause(s)
- Permanently fix and improve performance
- Seek total understanding of the process: How did that happen?"
- Take time to understand the big picture, to dialogue, and to elicit diverse perspectives, to apply the solution.
- Optimize the whole enterprise.
- Focus on improving processes that actually effect performance metrics.

Effective communication is mandatory

- Between Supplier and Customer to immediately stop the problem getting worse, ensure full understanding of the problem and verify that implemented solutions are satisfactory.
- Inside the organization where the problem originated, between all actors of the supply chain to ensure effective root cause analysis and definitive corrective action implementation.

ISO 9000:2000 Terminology

- **Nonconformity:** Non-fulfillment of a requirement.
Note: It may be a non conforming product but also a late delivery, an incorrect paperwork, incorrect process (production or QMS related), etc...
- **Correction:** the action taken to fix the nonconformity
- **Corrective Action:** the action taken to fix the cause of the nonconformity and to prevent recurrence
- **Preventive Action:** the action taken to prevent nonconformities or problems from occurring

Terminology: New definitions

(Future IAQG 9136)

- **Apparent Cause:** The event or action that immediately results in or precedes the nonconformity. May also be called Obvious Cause, Direct Cause, Immediate Cause
- **Root Cause(s):** The original event(s), action(s), and/or condition(s) generating (directly or in cascade) an actual or potential undesirable condition, situation, nonconformity or failure.
 - Note: There are often several root causes for one problem
- **Contributing Causes:** Contributing causes are causes that taken alone would not cause the problem but can increase the risk of the issue to happen. Analysis for these causes generally require taking small steps (or a finer look) to be identified and fixed.

Terminology: New definitions

(Future IAQG 9136)

- Root Cause Analysis (RCA): The process of identifying all the causes (root causes and contributing causes) that have or may have generated an undesirable condition, situation, nonconformity or failure.
- Containment - the action to mitigate impact of the problem and protect the operations/customers (stop the problem getting worse). Includes correction, immediate corrective action, immediate communication and verification that problem does not degrade

Terminology: New definitions

(Future IAQG 9136)

- Immediate Correction: Action(s) taken to immediately fix the nonconformity.
 - Note: For a product non conformity, correction might be understood as reworking the part, accepting the non-conformance through concession process, or ultimately scrapping it. For a system issue, it may include correcting the paper work or issuing a new purchase order. For a delivery issue, it may include air transportation instead of by truck or by ship, increasing production rate, etc
- Immediate Corrective Action: Action(s) taken to eliminate, prevent, or reduce the probability of any additional non-conformances related to the apparent cause from happening again in the short term.
 - Note: These actions may be temporary and should remain in place until root cause(s) is(are) identified and permanent root cause corrective action(s) is(are) implemented and verified to be effective.

Terminology: New definitions

(Future IAQG 9136)

- Root cause corrective action (or permanent corrective action): The corrective action(s) implemented to address the root cause(s) and contributing cause(s) of the undesirable condition, situation, nonconformity or failure and that will permanently prevent recurrence
- Root cause (or Permanent) corrective action verification: Actions taken to verify that the planned actions were taken as scheduled.
 - Note: This includes specific actions, milestones, completion dates, and responsibilities.

Terminology: New definitions

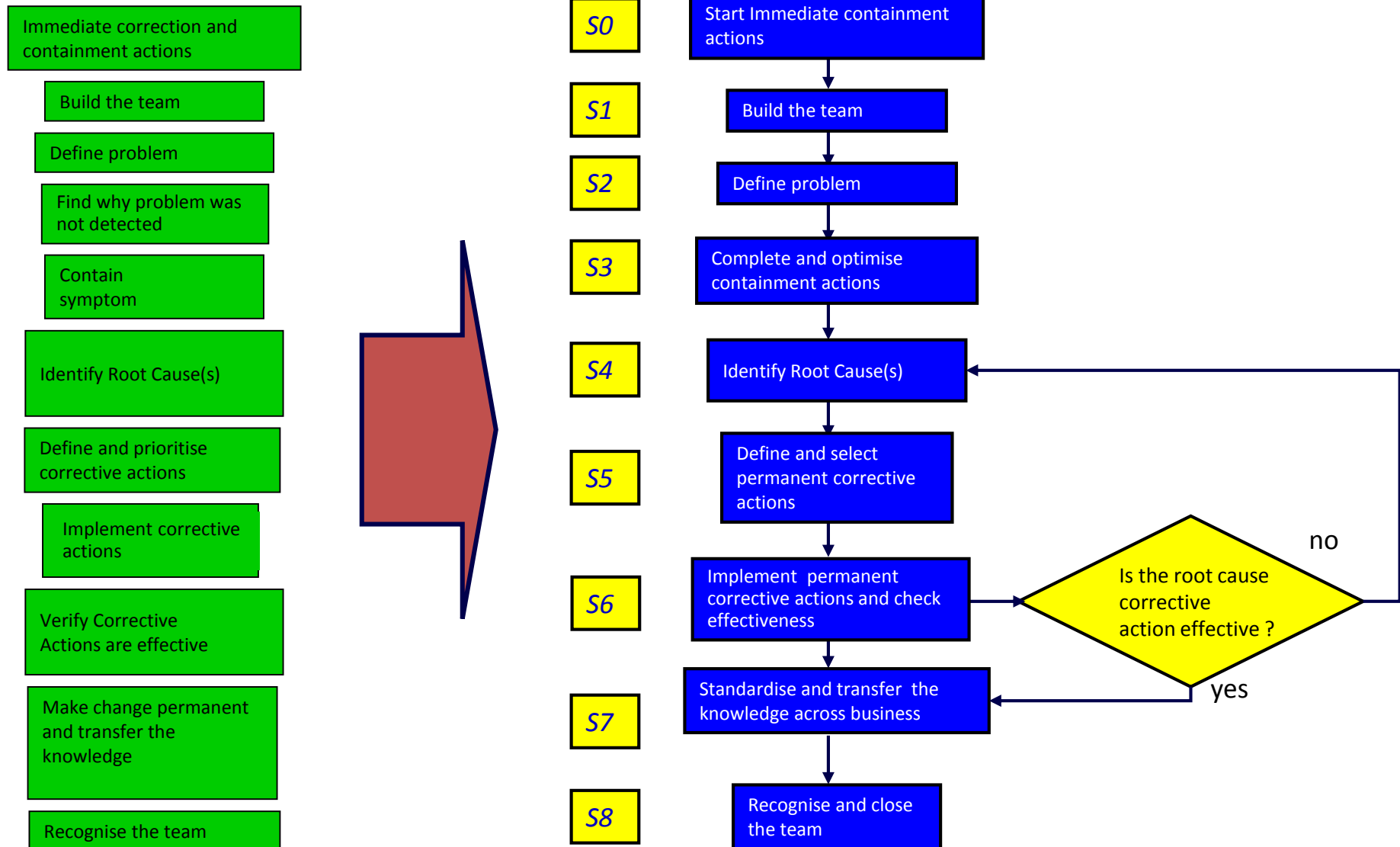
(Future IAQG 9136)

- Root cause (or Permanent) corrective action effectiveness: Actions taken to verify that the planned actions have permanently prevented recurrence of the identified root cause(s).
 - Note: This may include auditing, monitoring of specific metrics, or any other reporting methodologies.

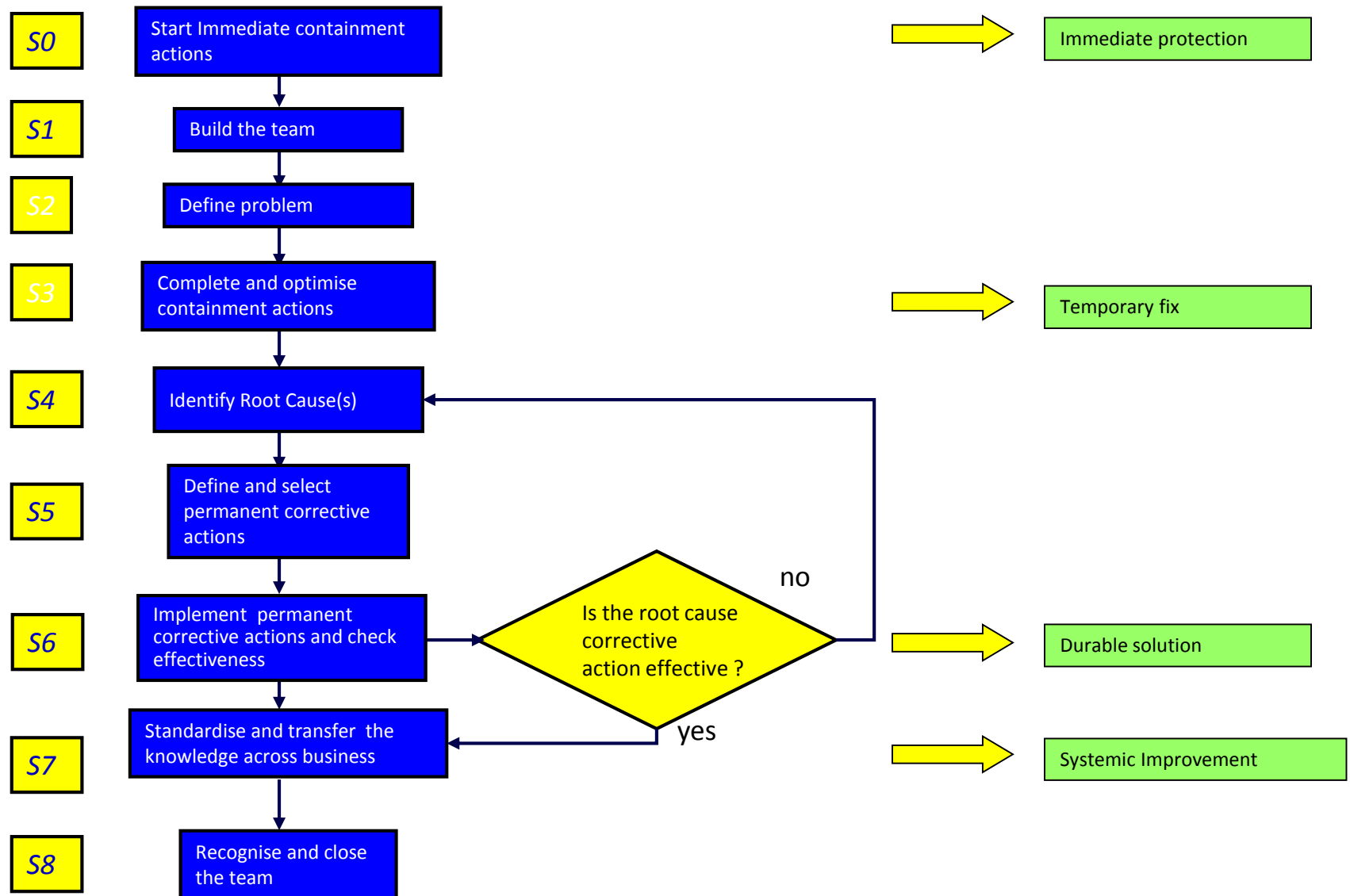
Relationship between some existing Root Cause Analysis methodologies

7-Step	8D	MTU & Airbus - 8D	Boeing model		Rolls-Royce 7 Step	Safran Impact 8D
1.Select project/theme	1. Identify team	1. Immediate containment	Correct, Contain, Communicate	Corrective Action	1. Define Problem	
	2. Define problem	1. Identify team			2. Contain problem	1. Build the team
	3. Contain symptom	2. Define problem			3. Find root cause of escape	2. Describe problem
3. Contain symptom		Identify Root Cause	4. Prevent further escapes	4. Find the root causes		
4. Identify root causes			5. Find root cause of problems		5. Find and grade corrective actions	
2. Grasp present status	4. Identify root causes	4. Identify root causes	Root Cause Corrective Action	6. Implement corrective action	6. Do corrective actions and make sure they are efficient	
3. Analysis		5. Choose corrective action				Root Cause Corrective Action Verification
	4. Implement corrective action	6. Implement corrective action	8. Conclude the process and congratulate the team			
5. Check the effects	7. Make change permanent	7. Make change permanent		Root Cause Corrective Action Follow Up	8. Conclude the process and congratulate the team	
6. Standardise and control	8. Recognise the team	8. Recognise the team				
7. Conclusions and future plans						

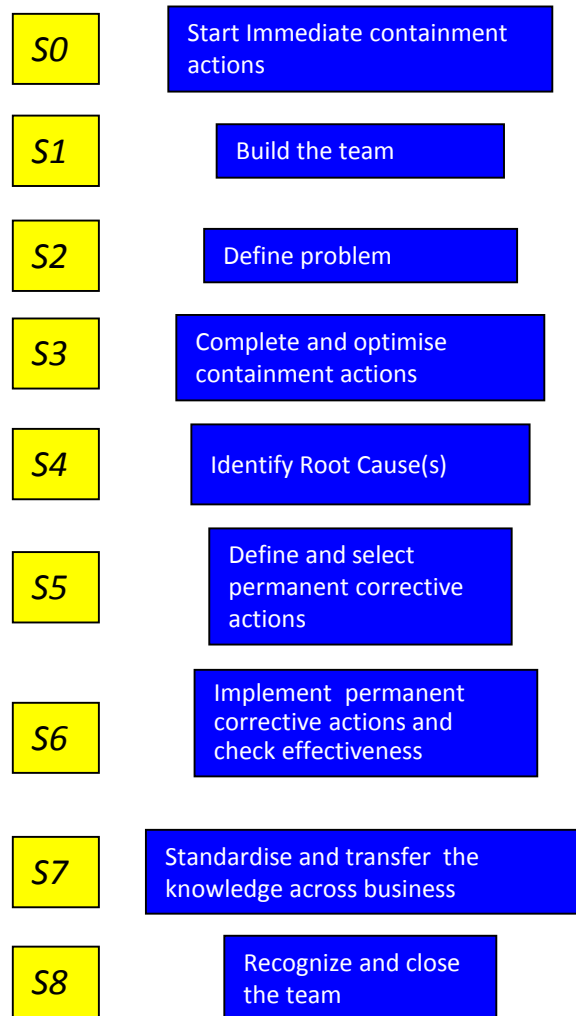
9136 Process Steps based on these existing methodologies



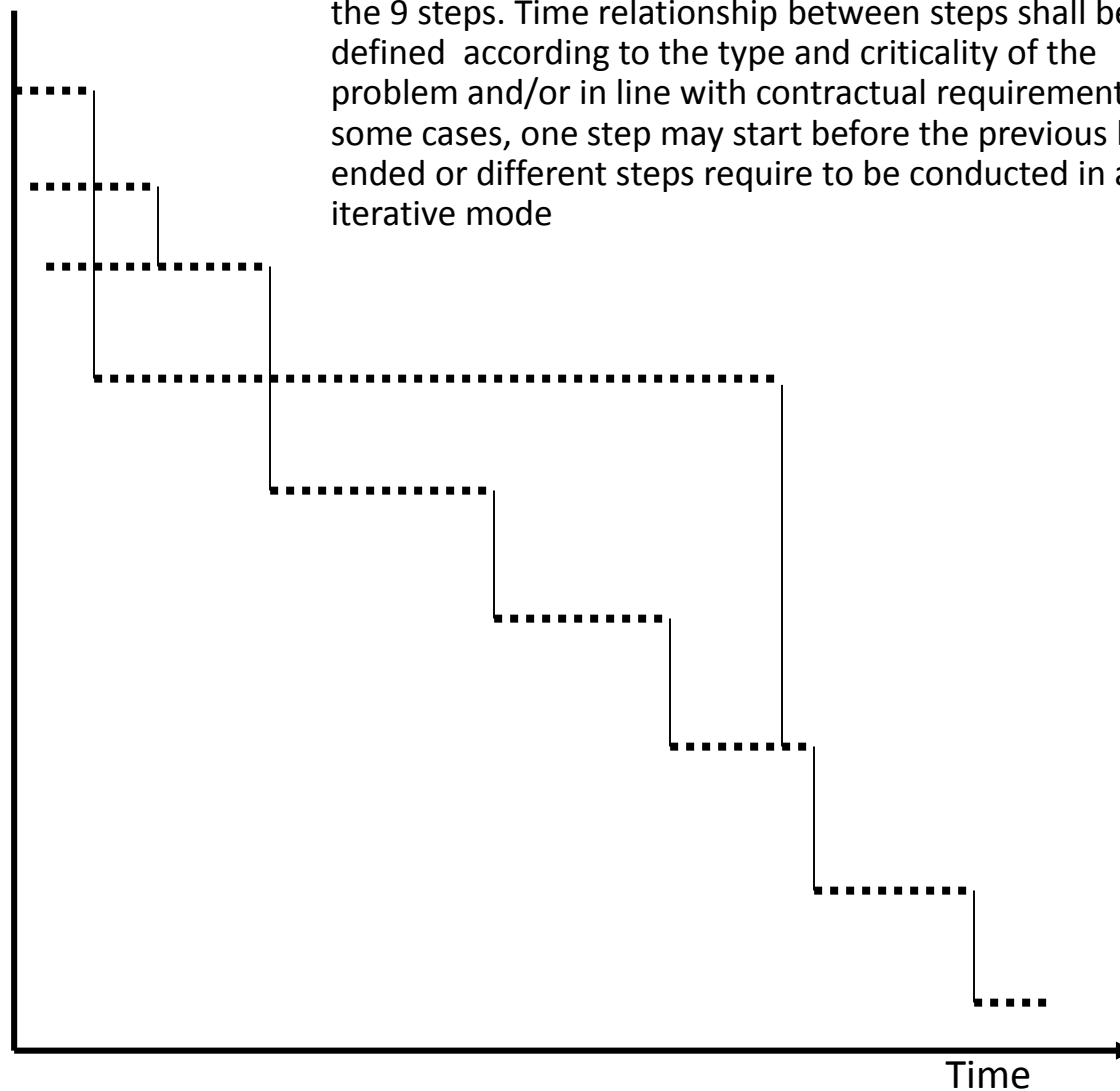
Process Steps and Results



Sequencing Consideration



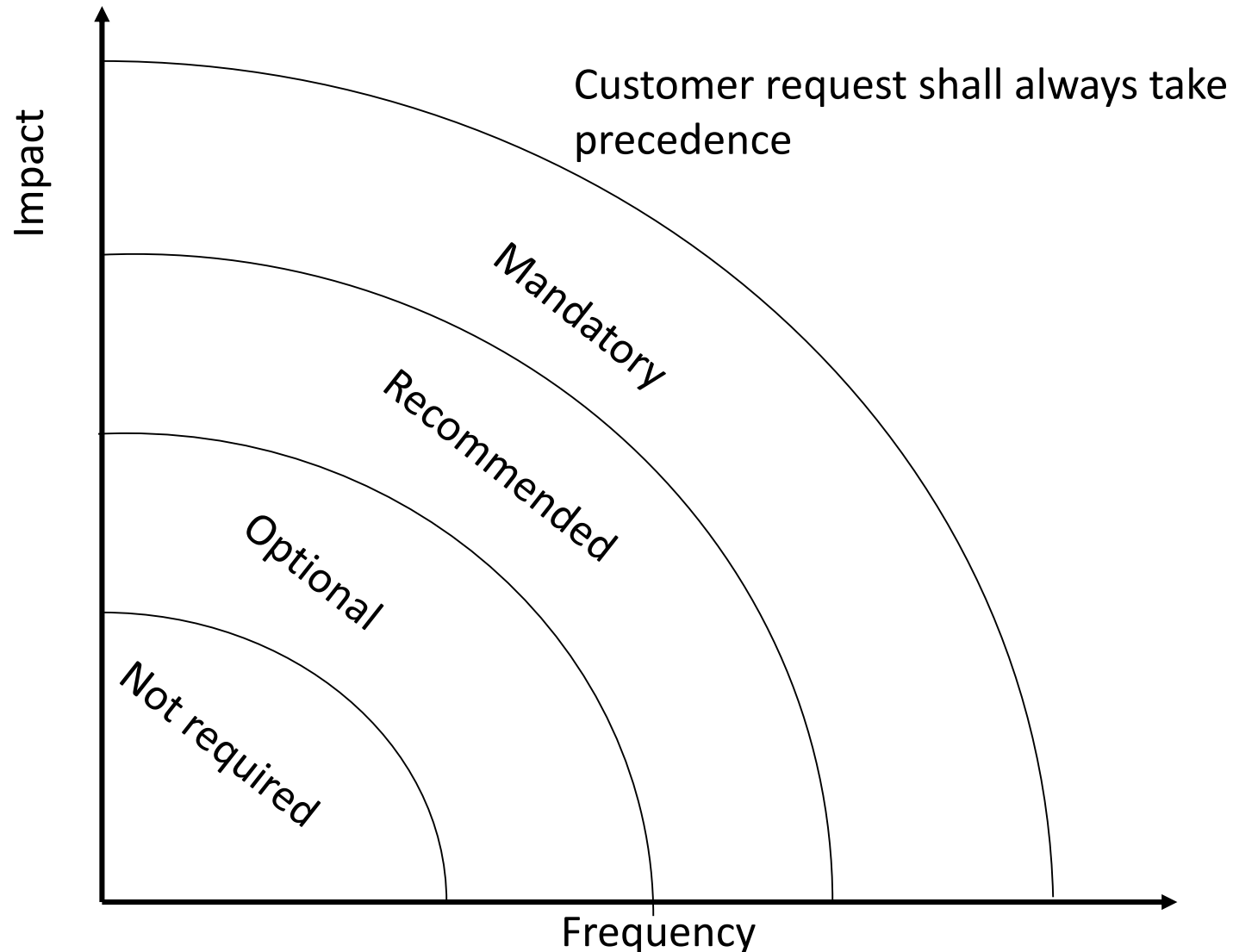
This diagram provides the typical sequence in applying the 9 steps. Time relationship between steps shall be defined according to the type and criticality of the problem and/or in line with contractual requirements. In some cases, one step may start before the previous has ended or different steps require to be conducted in an iterative mode



When to launch a structured root cause analysis and problem solving process?

- Launching a formal Root Cause Analysis and problem solving process shall always be considered when an issue (undesirable conditions, defects and failures) is detected.
- Decision not to apply the process shall be made based on objective evidence of absence of risks.
- In any case it shall be applied if one or more of these conditions exist
 - Safety impact
 - Product strength, performance, reliability issue
 - High impact on operations
 - Stop the line, prevent next operations to occur satisfactorily, etc
 - Regulatory authorities and/or customer dissatisfaction
 - Costs issue (generated to your Customer or to your organization)
 - Repetitive problems (on one part, similar activity or similar process)
 - Difficulty to detect
 - Customer request
 - Significant QMS issue

When to launch a structured root cause analysis and problem solving process?



Step 0: Start Immediate containment actions "Stop the Bleeding"

- **Objective:** To mitigate the impact of the problem, protect the customer operations and the organization (stop the problem from getting worse) and verify that the problem does not degrade until the root causes are known.
- **Output:** Immediate containment actions implemented, Customer protected
- **WHAT:** First thought "What do we have to do to protect the Customer and the organization eliminating the impact of the effect?"
- **WHY:** The problem that has been identified is having an impact now on the customer or on the organization. If we don't do anything, the problem will degrade: This justifies a containment plan.
- **WHEN:** Action generally required within 24 hours (less in critical cases).
- **WHO:** Must be assigned to an individual for implementation.

Step 0: Start Immediate containment actions “Stop the Bleeding”

- HOW:
 - Identify, isolate, perform immediate correction of all defective parts or data
 - Identify apparent cause and perform immediate corrective action to eliminate, prevent, or reduce the probability of any additional non-conformances from happening again in the short term.
 - Typical immediate containment actions may include
 - immediate stop of the working process
 - Stop deliveries
 - Recall product (still within the organization or already delivered)
 - Over inspection - “Build the wall higher”
 - Inventory checks and segregation of defective parts
 - Identify immediate potential risk on same parts if not detected: Determine apparent criticality: “Am I able to assess criticality”? If not, who should I inform (customer, design office, type certificate holder, airworthiness office ?...) to assist me in evaluating the criticality.
- Note: Immediate containment actions terminate when corrective actions are in place or when study has found a more effective containment action (Step 3 or Step 6): Immediate containment actions must have an agreed effective life span

Step 0: Start Immediate containment actions “Stop the Bleeding”

- **COMMUNICATION:** You are likely to require communicating and implementing action(s) across various entities and organizations.
 - Identify who is affected by the issue
 - Has the issue an impact now (internally or to your customer)?
 - Inform all impacted parties (next cell, sub-tiers, customer, etc)
 - Product or data concerned
 - Nature of the issue as known at this time
 - How and when it was detected
 - Apparent consequences
 - Containment actions taken and recommended actions at customer level when relevant
 - What is the next step (e.g. if Root Cause Analysis process is being considered - see specific page later)
 - If customer help is required (e.g. to determine criticality)
 - When next communication will occur
 - Who is the focal point at this point in time
 - Immediate information to the customer is mandatory if product has been delivered which is known or suspected to be affected by the issue, potentially impacting safety and more generally having a significant impact on customer's operations.

Step 0: Start Immediate containment actions “Stop the Bleeding”

- TO BE CONSIDERED:
 - Who is suffering or may suffer from the issue and where?
 - How and where is it necessary to contain problem?
 - What are the investigations to be undertaken to know more about the issue?
 - Are there other products or production lines or data that could be affected by a similar issue and that require similar containment actions to be launched at other sites, at customer, ...?
 - What is being done to contain this issue & how is the customer informed and being protected?
 - How are finished products in stores, WIP (Work In Process), at suppliers and customers being managed?
 - What checks are being performed or should be launched, by who and where?
 - What is the planned date for permanent resolution (allows to evaluate how long the containment actions are likely to remain in place)?
 - Which data do we need to collect to support deeper analysis?

Step 1: Build the team

- Objective: To ensure that all different actors (organization, suppliers, customers) and functions that may have an influence on the corrective action process, including identification of the root cause(s), are in the team
- Outputs: Cross functional team of experts in place
- WHAT: Gather a team representing different functions that may have an influence on the problem and that are prepared to assist in its resolution.
- WHY: The corrective action process, including root cause analysis is always more successfully conducted by a team knowing the process and owning the data, than by individuals.
- WHO: Top management must support the team approach to the corrective action process
 - Note: For big issues, it is recommended to set up a steering committee composed of members at adequate level of management (not participating to the working Root Cause team) able to validate decisions within the entire organization and ensure right level of empowerment.

Step 1: Build the team

- WHO (continued):
 - Team leader (facilitator) shall be nominated
 - Should preferably be someone without any hierarchical role (not directing the analysis but ensuring targets and timing are met)”
 - Must be empowered by the appropriate management level commensurate to the issue
 - Must be nominated based on experience of root cause analysis techniques or must have access to the appropriate help by specialists, but must not be necessarily an expert in the processes/problems being analysed.
- WHEN: As soon as problem is considered as justifying a root cause analysis.
- Note: Step 1 (Build the team) and Step 2 (Define problem) may be conducted concurrently in an iterative process

Step 1: Build the team

- HOW:
 - Identify representatives from functions that may contribute to the corrective action process, including identification of the root causes (see table)
 - Assign responsibilities and objectives
 - Notes:
 - Remember, those performing the job (operators, inspectors, assemblers, etc) are the best to identify the real causes: Don't leave them out of the team !
 - Size and composition of the team depend on the complexity and on the impact of the problem
 - The composition of the team is not fixed forever and may evolve depending on the analysis results and needed actions: New actors may join the team if analysis shows they are identified as being in the scope, some others will leave if their area is definitely identified as out of the scope.
 - However, consideration should be made that expanding the size of the core team over 6 to 8 members generally results in less efficiency. When more members or special skills are required, sub teams should be considered.
 - Don't forget a root cause analysis shall NOT be used for blaming or transferring responsibility

Step 1: Build the team

- COMMUNICATION:
 - Team leader needs to know that he has been nominated, why he has been assigned this role and the team objectives and constraints
 - Each team member needs to understand his role and objectives
 - The management of each team members needs to know level of involvement of his staff (time, duration, role)
 - All stake holders must be informed of the team composition and objectives

Step 1: Build the team

People joining the team must be selected based on how they are impacted by the problem and how they can help to find an effective corrective action.

	Sees the problem	Suffers from the problem	Is in charge of solving the problem	Could help solving the problem	Could contribute to the problem	Will help selecting solution	May be impacted by the or disturbed by the fixing of the problem	Others
Name 1								
Name 2								
Name 3								
Name 4								
Name 5								
Name 6								

Above selection criteria for example only, others may be found

Step 1: Build the team

- **To be considered:** Team dynamic can have positive or negative results: It is therefore important to ensure that the team leader is selected on ability to effectively manage team dynamics:

<u>Positive Outcomes</u>	<u>Negative Outcomes</u>
Leads to new ideas	Diverts energy from work
Stimulates creativity	Threatens psychological well-being
Motivates change	Wastes resources
Promotes organizational vitality	Creates a negative climate
Helps individuals & groups establish identities	Breaks down group cohesion
Serves as a safety valve to indicate problems	Can increase hostility & aggressive behaviors

Step 2: Define problem

Go – Look – See

- Objective: To understand the significance, impact and size of the problem and ensure the situation is fully described and understood
- Output: Problem defined and agreed (which product, which process, which defect or deviation)
- WHAT: This step helps to fully describe a situation, precisely analyse all its elements and gain a common understanding of them, allowing defining an action plan
- WHY: Often, the first time a problem is put into words, it is vague, subjective or even abstract. Without a proper problem definition, it is likely that root cause will not be identified and wrong or insufficient actions will be put in place
- WHEN: As soon as the team is formed
- Note: Step 1 (Build the team) and Step 2 (Define problem) may be conducted concurrently in an iterative process
- WHO: All the team

Well begun is half done....

Step 2: Define problem

Go – Look – See

- HOW:
 - A good problem statement is supported by objective evidence, based on facts and figures, not on perception
 - Must understand the scope and extent of the problem and the symptoms which are being experienced by the customer (either internal or external)
 - Effect - Something resulting from a cause.
 - Cause - Something producing an effect.
- Notes
 - This may be an iterative process and could take some time.
 - The problem statement should be updated as more information is gathered
- COMMUNICATION:
 - Continual communication between all team members is mandatory, for instance through regular reviews until problem is clearly identified, defined and agreed by all.
 - Problem definition and extent must be communicated to all stake holders and agreed, especially by the customer when he is impacted.

Step 2: Define problem

Go – Look – See

- TO BE CONSIDERED:
 - Which are the elements (operations, products, materials, defects, malfunctions, ...) that may characterise the situation ? What is it about (process step, ...) ?
 - Who is concerned with the problem? Who is reporting the problem? Who is rectifying the problem? Who is the problem affecting?
 - Where are all the places where the event takes place (shop floor, services, machine, process step, ...)?
 - Where is it seen ? Where does it originate ?
 - When does the event appear (time, date, when does it start, how long does it last, how often, ...)
 - When is the problem reported?
 - Has it occurred before? If yes, what is the history?
 - How do we know there's a problem (how is it detected)?
 - How does the event appear, how does it stop ?
 - How frequently is the problem experienced?

Step 2: Define problem

Go – Look – See

- TO BE CONSIDERED (continued):
 - How is the effect of the problem being measured (costs, delays, scrap rate, customer complaints, return rate, concessions, reliability rate, etc)?
 - How is the problem currently addressed ? How is it corrected?
 - Why is there an action to take place (customer impact, cost impact, safety impact, ...)?
 - Natural tendency is to try finding the root causes at this stage, whereas you are not sure yet of what the real problem is.
 - Check every answer above by asking: "Do we know this for sure, or are we just assuming that this is the way things are?"

Step 2 should always be concluded by confirming that all team members agree about the definition of the issue and resulting impact

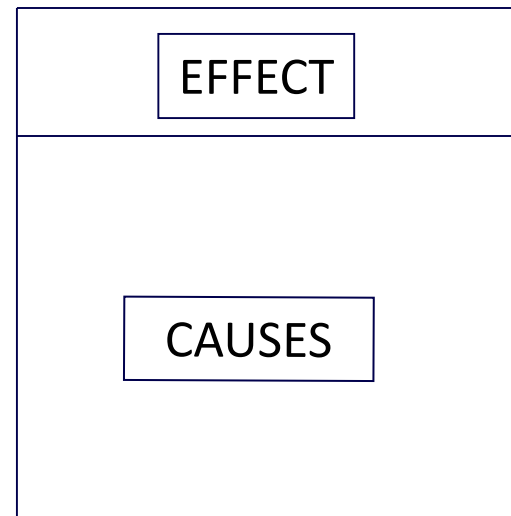
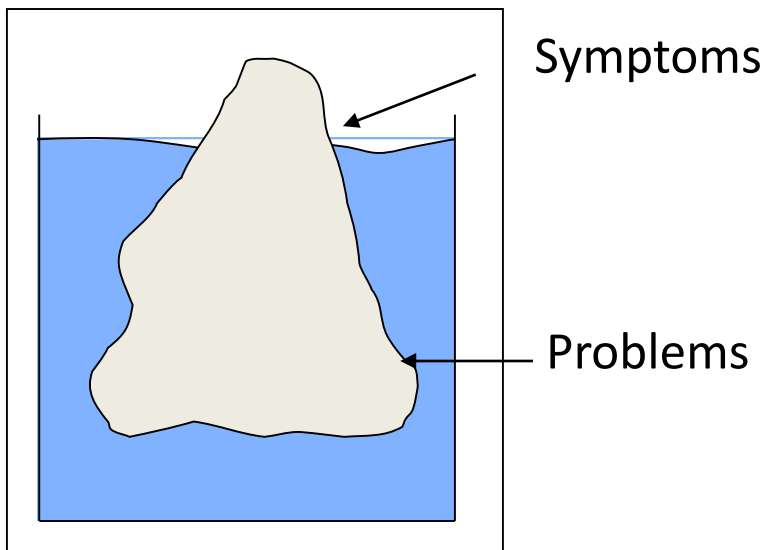
Step 2: Define problem

Go – Look – See

- Problem recognition

- Effect - Something resulting from a cause .
- Cause - Something producing an effect .

Compare a problem to an Iceberg !



Problem statement is a factual description of the PROBLEM EFFECT

Step 2: Define problem

Go – Look – See

- TOOLS :
 - Some tools may be used to gather and analyse data for problem definition
 - Brainstorming
 - Is/is not
 - Comparison sheet
 - Check Sheets and Tally charts
 - Histograms
 - Scatter Diagrams
 - Control Charts
 - Pareto Analysis
 - Etc

Step 2: Define problem

Go – Look - See

The
IS / IS NOT analysis

(Helps to identify
exactly what the
problem effect IS...
But also, what it IS
NOT).

PROBLEM DEFINITION WORKSHEET – IS/IS NOT ANALYSIS			
Problem Profile	IS	Logically Could be but IS NOT	Gather Data
WHAT	1. What Object	Pacific Engine Covers	Atlantic engine covers
	2. What Defect	Gaps in paint due to poor paint adhesion	Paint peeling/Flaking /blistering/runs/sags/scratches/inclusions/colour abnormalities/dull colours
	3. Where Seen Geographically / on component	Randomly on surface	In a specific area
WHERE	4. Where First Observed	Final inspection area	Spray booth/assembly areas/customers
	5. Where Seen Since	At the ERA in the inspection area	Final inspection/customers/ despatch
	6. When First Seen	A few days before the 24 th of May, in the inspection area	Prior to 2 weeks ago. After shipping
WHEN	7. What Pattern Since	In batches at regular intervals	Continuous, sporadic
	8. How Many affected?	6% (4.5% above normal rate)	More or less than 6%
	9. What Size	Random sized defects	Specific size
HOW BIG	10. Defects per Part	1 - 10 defects/ part	Not more than 10 defects/per part
	11. What is the trend?	Stable	Increasing or decreasing

Step 2: Define problem

Go – Look – See

Comparative analysis: allows identifying at which date differences appeared, or when changes - process , staff, design, etc - were introduced, possibly to have generated the issue.

Description and comparaison chart						
		« IS »	« IS NOT «	Particularity	Changes	Dates
WHAT ?	object					
	anomaly					
WHERE ?	location					
	object					
WHEN ?	calendar					
	cycle					
HOW MANY ?	object					
	anomaly					

Step 2: Define problem

Go – Look – See

The check sheet and the Tally chart

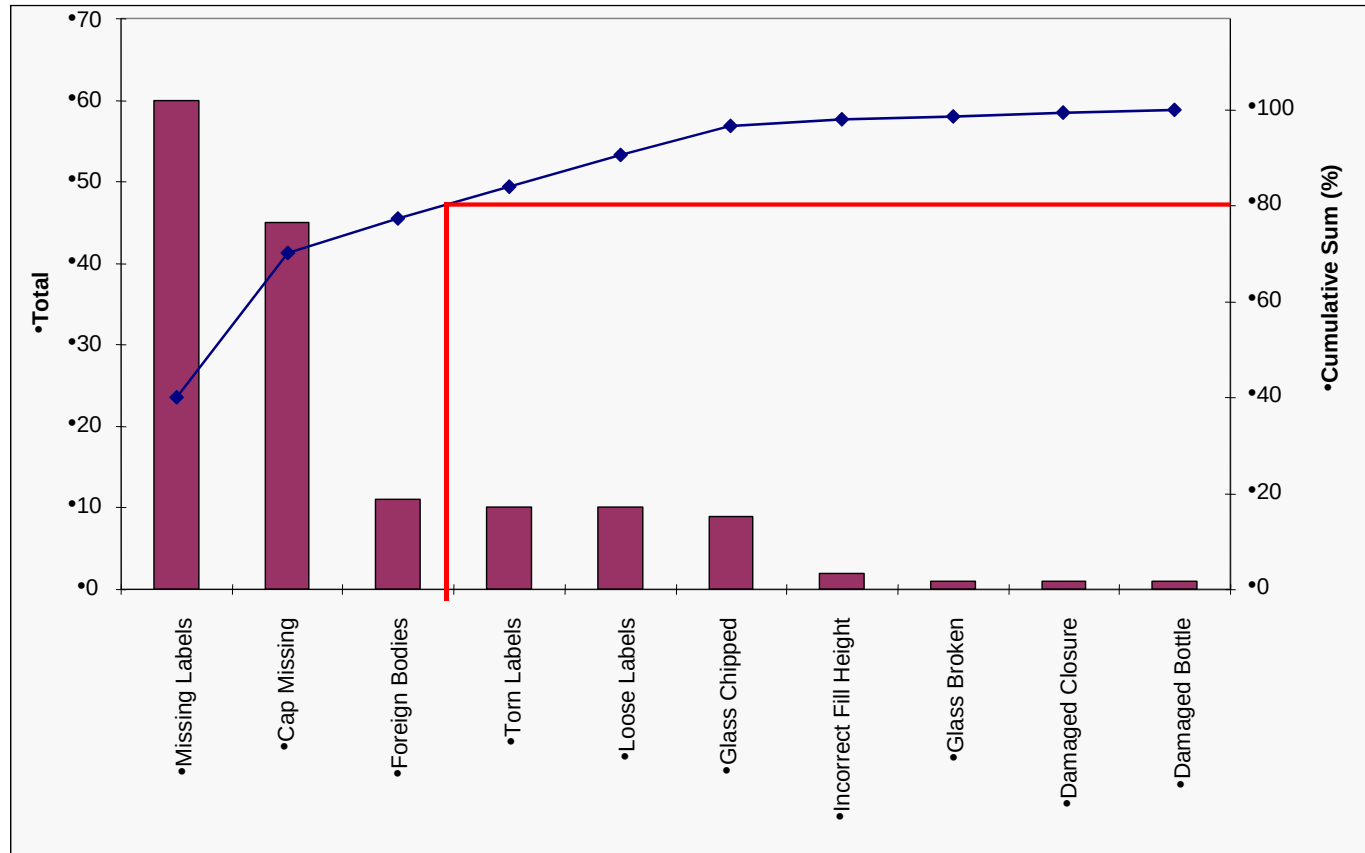
7.09	7.10	7.09	7.08	7.07	7.08	7.09	7.06	7.07	7.08	7.10
7.13	7.12	7.11	7.10	7.09	7.10	7.08	7.05	7.11	7.06	7.08
7.07	7.06	7.05	7.04	7.03	7.06	7.09	7.07	7.08	7.07	7.09
7.08	7.10	7.07	7.11	7.08	7.07	7.10	7.09	7.06	7.10	7.06
7.09	7.08	7.09	7.06	7.09	7.08	7.06	7.07	7.08	7.06	7.08
7.08	7.05	7.06	7.08	7.07	7.11	7.09	7.06	7.07	7.08	7.10
7.12	7.07	7.10	7.07	7.06	7.11	7.09	7.06	7.07	7.08	7.10
7.08	7.08	7.11	7.08	7.05	7.09	7.06	7.07	7.08	7.06	7.08
7.09	7.07	7.06	7.07	7.10	7.09	7.06	7.07	7.08	7.06	7.08
7.10	7.08	7.09	7.11	7.09	7.09	7.06	7.07	7.08	7.06	7.08
7.05										

CLASS	TALLY	TOTAL
7.13	I	1
7.12	III	3
7.11	IIII III	8
7.10	IIII II III	13
7.09	IIII IIII IIII III	18
7.08	IIII IIII IIII IIII IIII	25
7.07	IIII IIII IIII III	18
7.06	IIII IIII III	13
7.05	IIII III	8
7.04	III	3
7.03	I	1

Step 2: Define problem

Go – Look – See

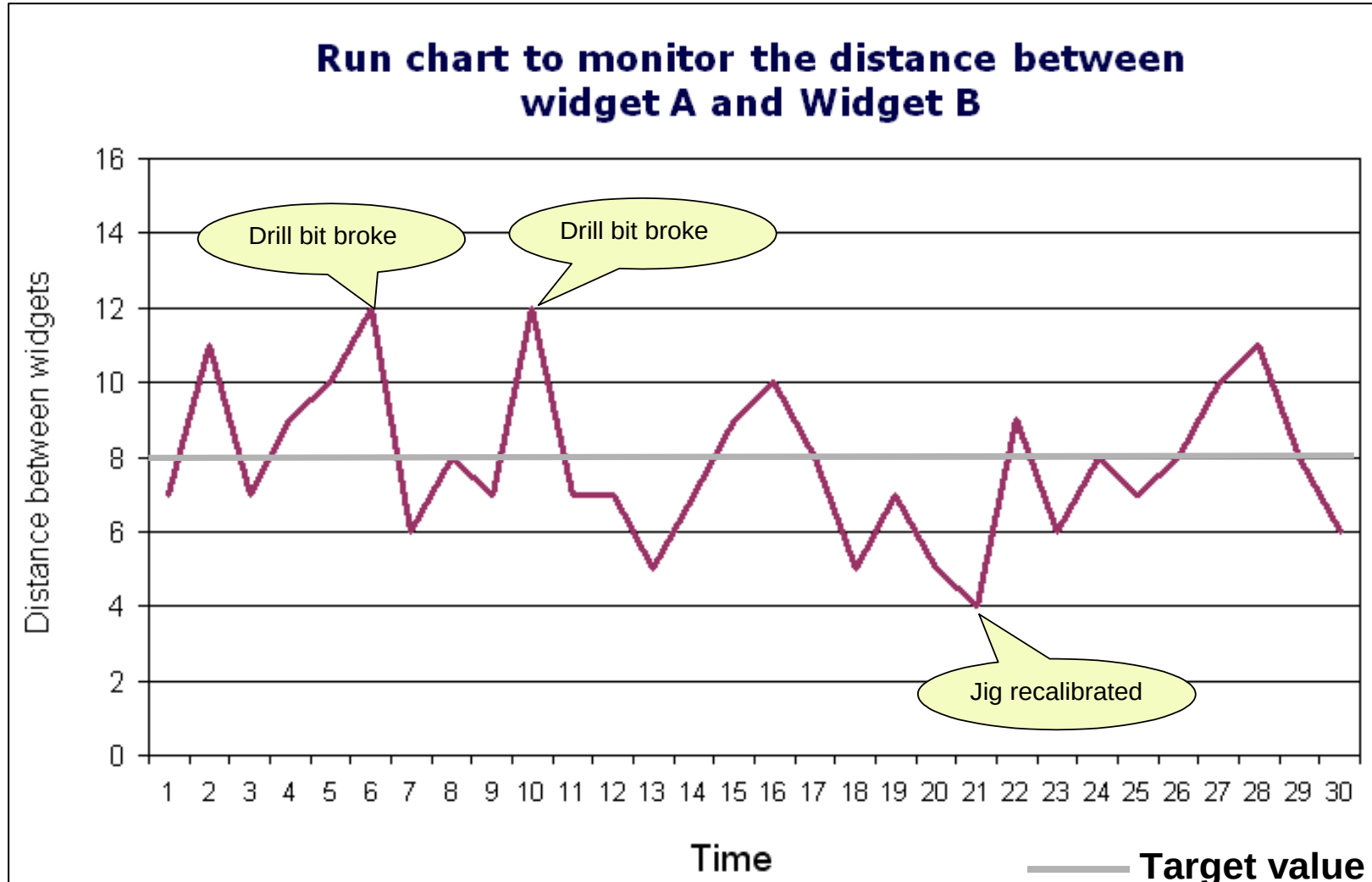
The Pareto chart



Step 2: Define problem

Go – Look – See

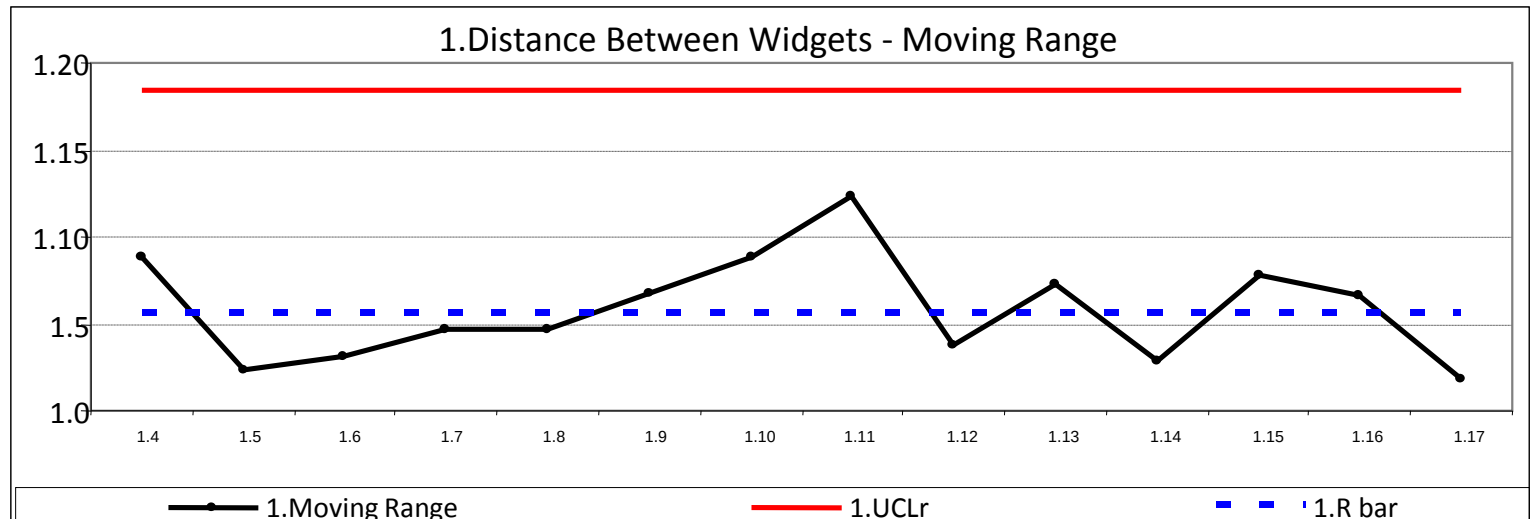
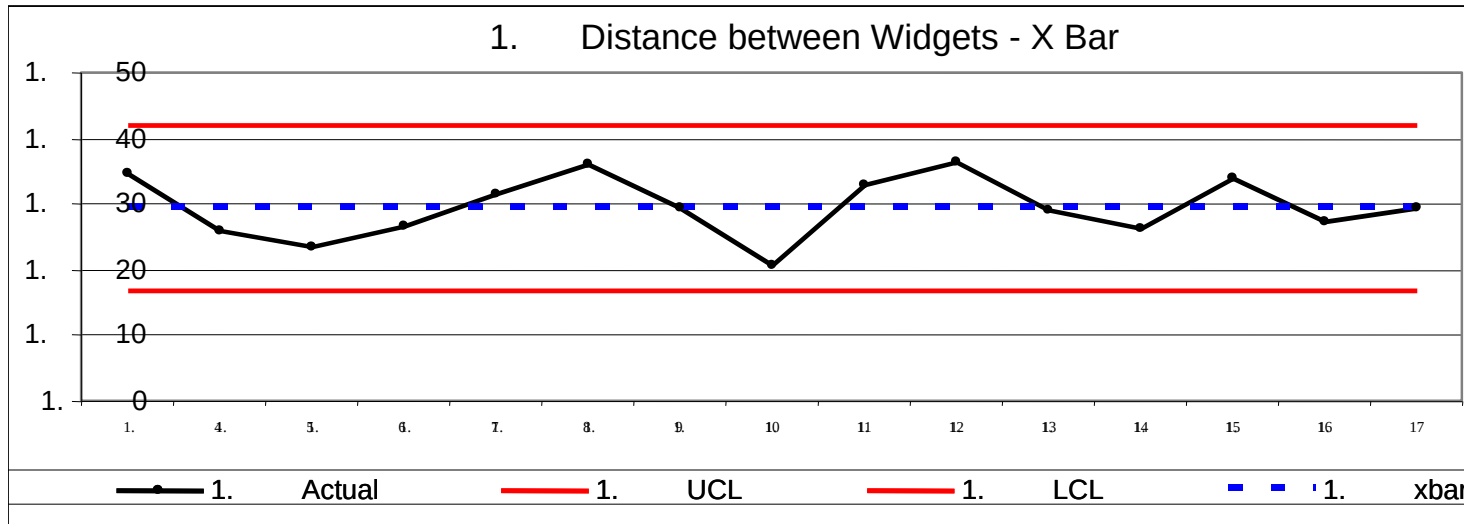
The Run chart



Step 2: Define problem

Go – Look – See

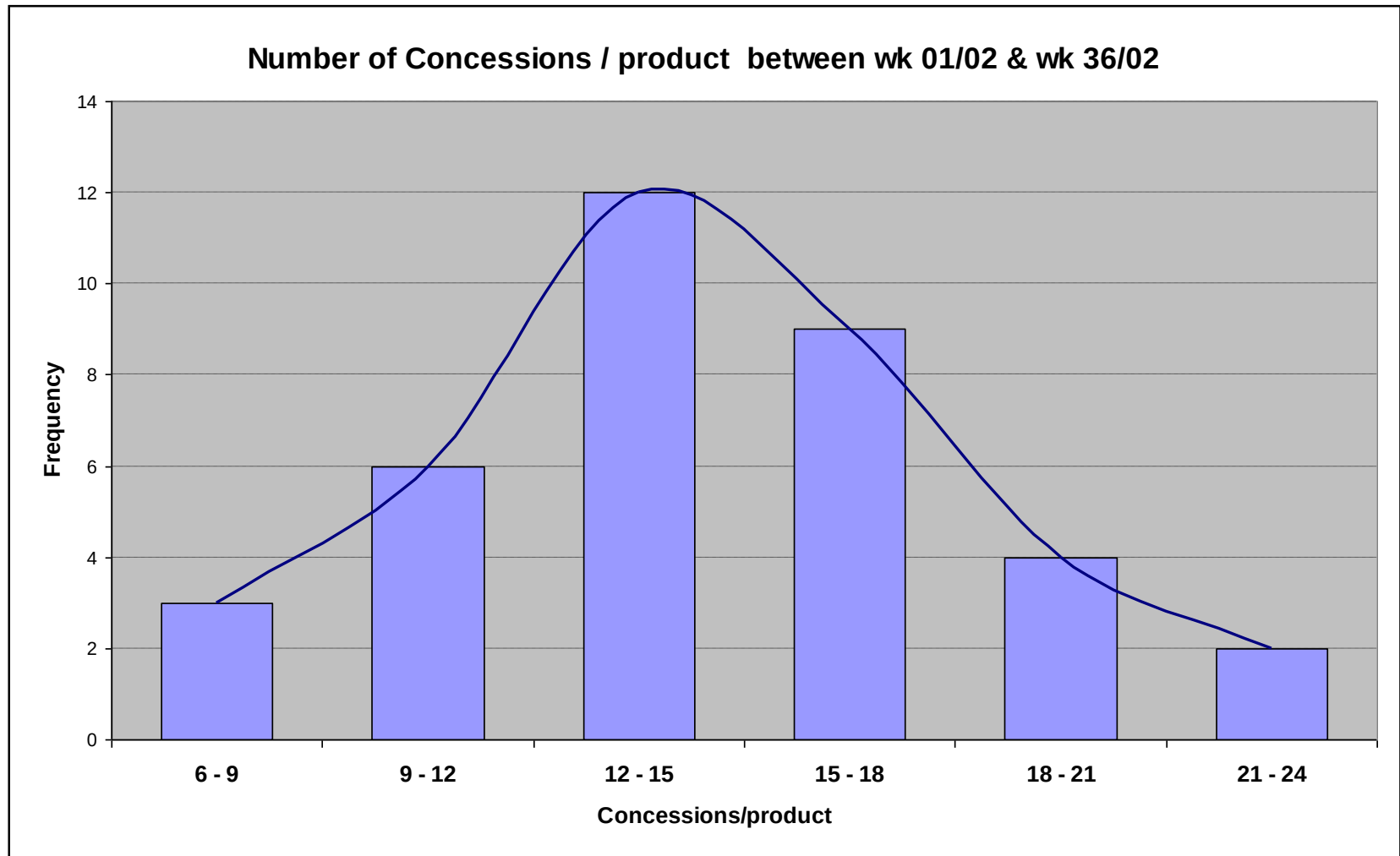
The Control chart



Step 2: Define problem

Go – Look – See

The Histogram

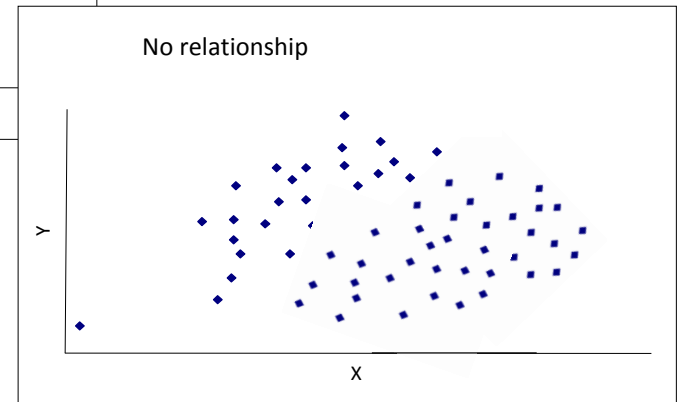
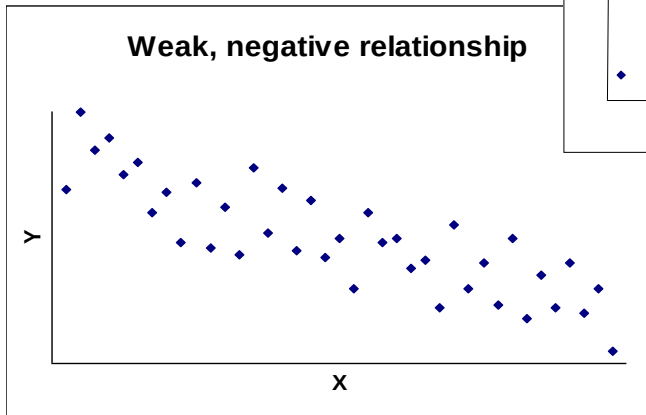
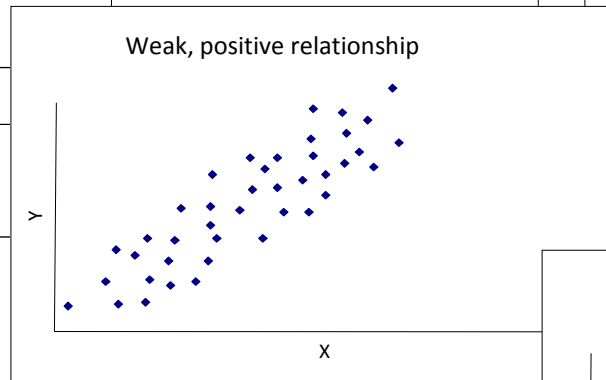
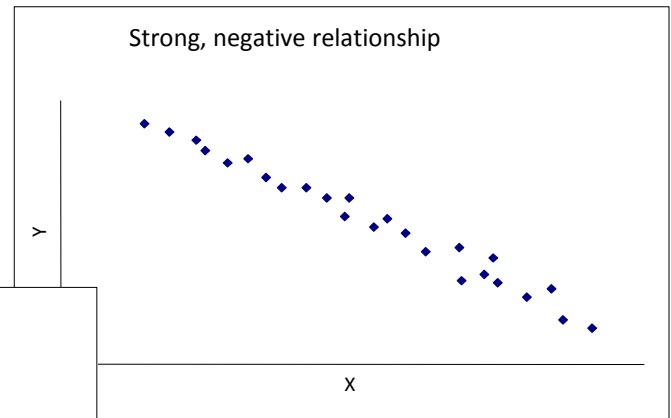
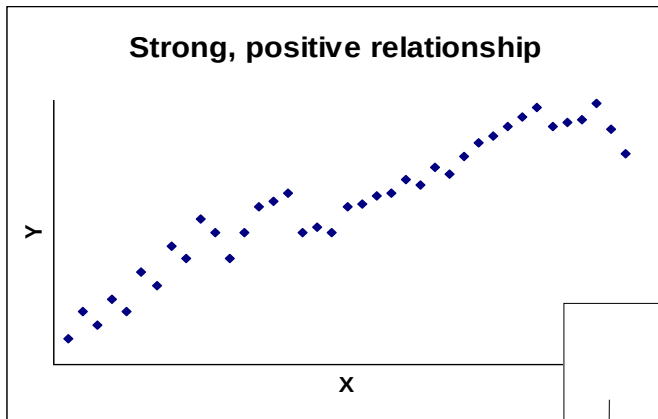


Step 2: Define problem

Go – Look – See

The scatter diagram

(shows relationships and how variables correlate)



Step 3: Complete and optimize containment actions

- Objective: To ensure containment actions suitably address the problem definition and to verify that immediate corrective actions are commensurate with the problem, implemented and effective
- Output: Completed and optimised containment actions implemented (symptoms contained)
- WHAT: To check that all non-conforming product or data has been isolated and corrected to prevent their escape, and optimise immediate corrective actions to minimise impact on the customer operation and the organization until the root cause of the problem is understood and permanent effective corrective actions are taken
- WHY: When problem is well defined, it is very likely that immediate containment actions need to be further developed, added, or optimised and some may be removed.
- WHEN: As soon as all team members agree about the definition of the issue and resulting impact

Step 3: Complete and optimize containment actions

- WHO: The owner of each action and all team members to verify effectiveness of actions taken to date
- HOW:
 - Identify action holders and time scales
 - Identify potential risk on same and similar parts or data if not detected
 - Confirm criticality with all team including suppliers and customer if required.
 - Generally, additional containment actions may include:
 - Temporary increase of production
 - Over inspection upstream in the process
 - Stock segregation in sub-tiers
 - Similar product recall (still within the organization or already delivered)

Note: Customer might be internal or external customer

Step 3: Complete and optimize containment actions

- **COMMUNICATION:**
 - Continual updating of communication between all team members is mandatory, for instance through regular reviews until containment actions are clearly identified, agreed by all and implemented.
 - Nature of containment actions must be communicated to all stake holders and agreed, especially by the customer if some product has been delivered and/or if he might soon be impacted (e.g. deliveries will stop)
- **TO BE CONSIDERED:**
 - Find why problem was not detected and act accordingly
 - Is initial (immediate) containment still required?
 - Containment plan may include other equipment, areas, data, etc... that could potentially be affected.
 - The containment plan should prevent the same issue arising at other sites, products or production lines of the suppliers
 - What checks need to be performed, by who and where ?

Step 3: Complete and optimize containment actions

- TO BE CONSIDERED (continued):
 - How products in stores, WIP (Work In Process), at suppliers and customers are being managed?
 - Do you have an estimation (order of magnitude) of how long it will take to implement actions that will permanently solve the problem (the answer to this question will give you an estimation of how long these containment actions are likely to remain in place).
 - How do you manage communication and action implementation across various entities and organizations?

The risk and natural tendency are that these containment actions, which should be temporary in nature, become permanent and people are satisfied with, so will never find the root causes.

Step 4: Identify root cause(s)

- Objective: To identify, through structured root cause analysis, all causes that have or may have generated or contributed to the undesirable condition, situation, nonconformity or failure, then select the most critical ones that require to be addressed.
- Output: All causes of the problem identified
- WHAT: To follow a structured process to identify all causes that when addressed by appropriate corrective actions, will permanently prevent the undesirable condition, situation, nonconformity or failure from recurring.
- WHY: No problem can be effectively and permanently solved unless all its origins, apparent or hidden, direct or indirect are identified and understood.
- WHO: All team members
- WHEN: Starts as soon as all team members agree about the definition of the issue and resulting impact and effective containment actions are in place

Step 4: Identify root cause(s)

- HOW:
 - Understand and map the Process
 - Define what actions need to be taken in order to find the root cause(s)
 - Measure current performance
 - Identification of root causes by Root Cause Analysis must be supported by objective evidence (facts and figures, not by perception) based on proven tool(s) which shall include verification of the relation between the cause(s) and the issue
 - Prioritise causes by performing a risk analysis based on:
 - Impact on the product, operations, customer, etc
 - Probability to occur
 - Detectability
 - Select those root causes that you want to address and those that do not require a corrective and preventive actions due to their low criticality

Note: Team leader must be nominated based on experience of root cause analysis techniques or must get the appropriate help by specialists

Step 4: Identify root cause(s)

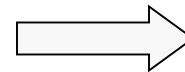
- **COMMUNICATION:**
 - Continual communication between all team members is mandatory, for instance through regular reviews until root cause are clearly identified and agreed by all
 - Root causes must be communicated to all stake holders and agreed, especially by the customer when he is impacted.
 - Communication internally and between various tier levels
- **TO BE CONSIDERED:**
 - Take care not to disperse in too many directions (better performing few effective investigations than many ineffective checks) but do not “jump” only on what appears as evident.
 - Interaction and combination of various causes
 - What failed in the quality system to allow the undesirable condition, situation, nonconformity or failure not to be detected?
 - Check if problem could have been detected earlier or somewhere else

Step 4: Identify root cause(s)

• TOOLS:

- Some tools must be used to enable problems to be defined, data to be collected and analysed
- Several tools may be used in step 4 (non exhaustive list, see also step 2 “Define Problem “as some are common to both steps):

Check sheets



Data Collection

Histograms

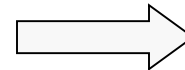
Scatter Diagrams

Run and Control Charts

Process mapping (Flow Charts)

Design of Experiment

Pareto Analysis



Data Collection & Analysis

Fishbone

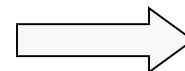
5 Why

Cause and effect

FMEA (Failure Mode and Effect Analysis)

FTA (Fault Tree Analysis)

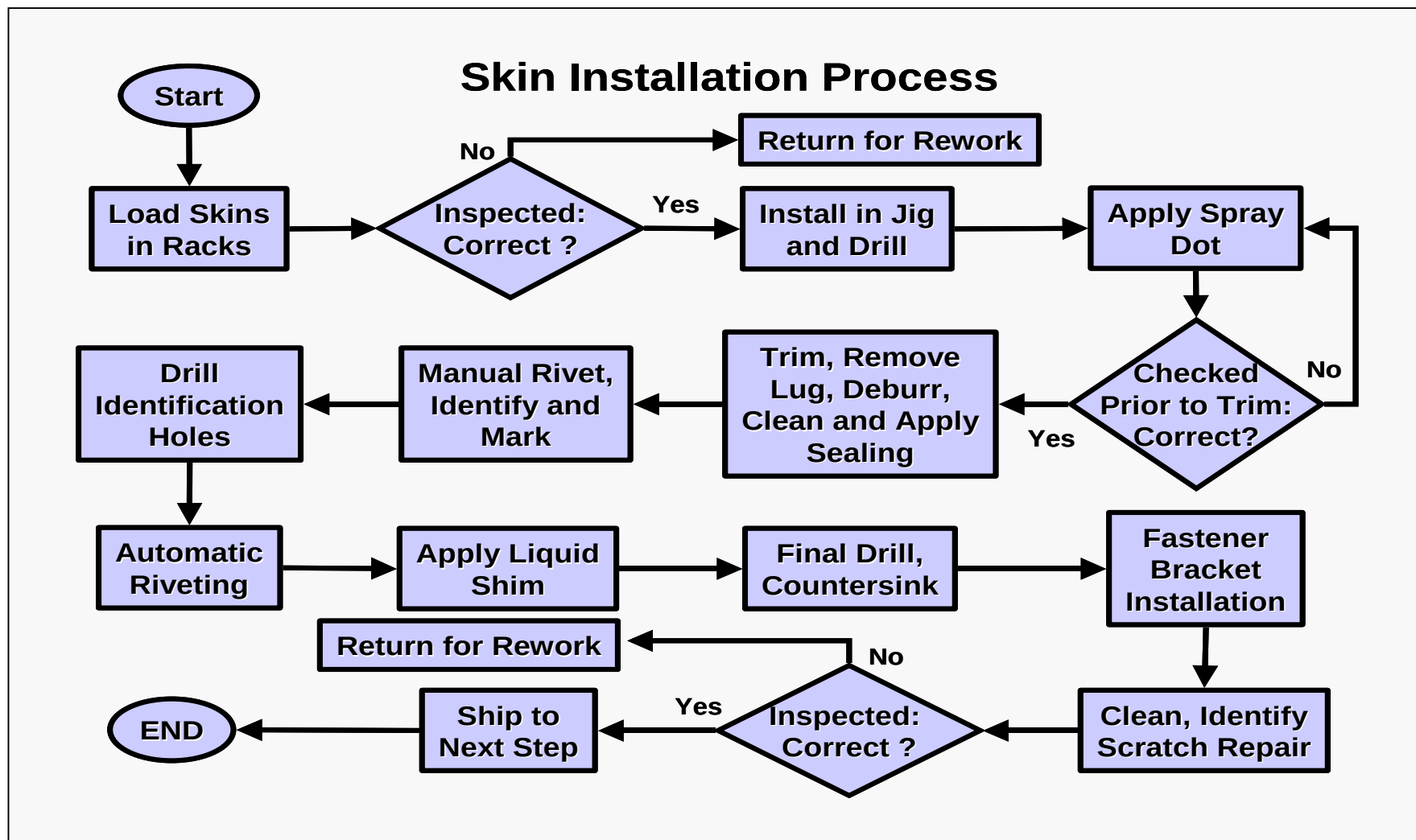
Root Cause Chain



Analysis Techniques

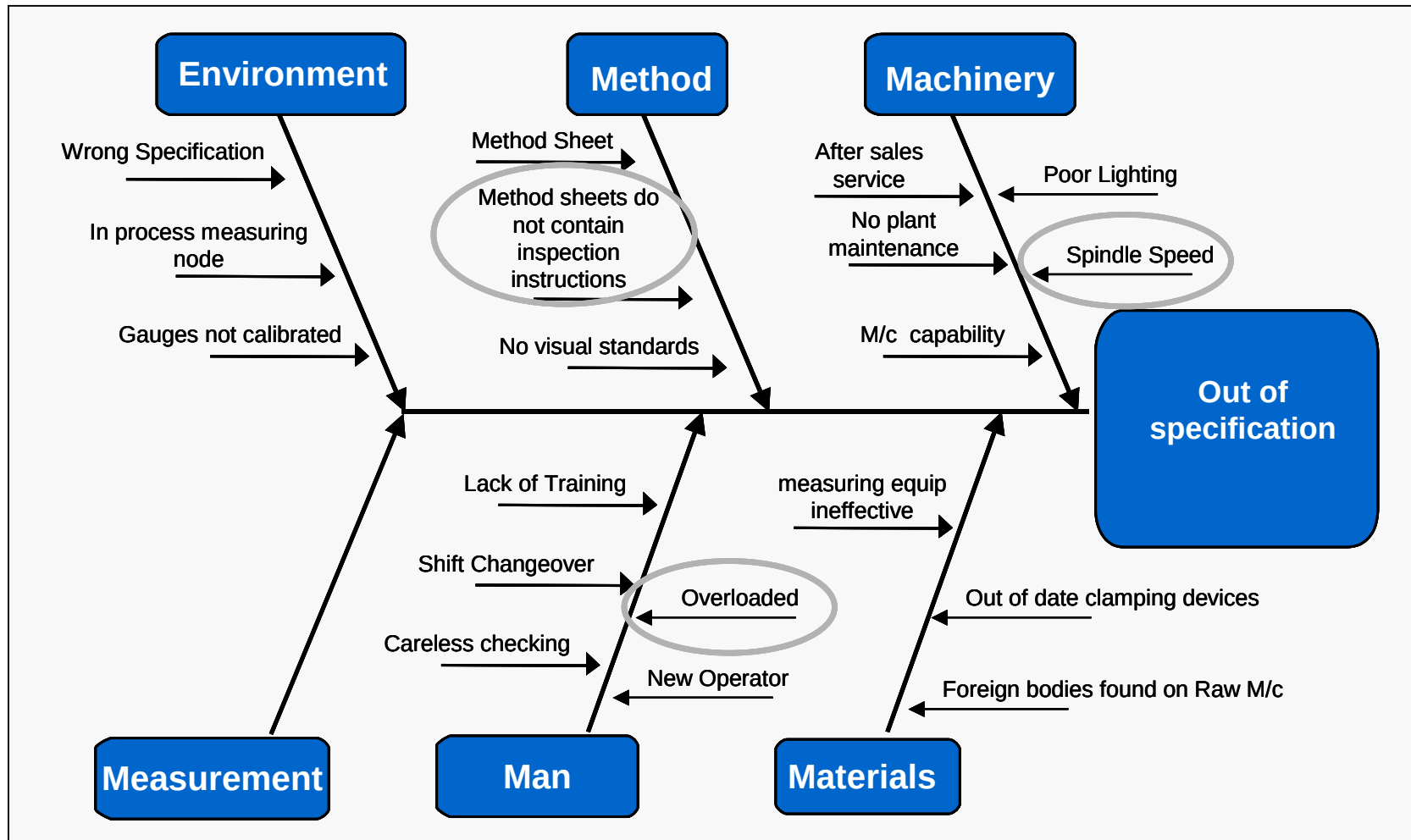
Step 4: Identify root cause(s)

The Process Mapping



Step 4: Identify root cause(s)

The Fishbone Analysis (Ishikawa)



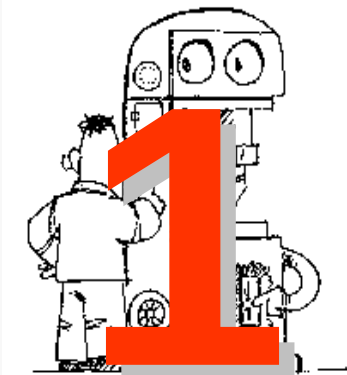
Step 4: Identify root cause(s)

FMEA (Failure Mode and Effect Analysis)

Number	Process Step	Potential Failure Mode	Potential Failure Effect	S E V	P o t e n t i a l C a u s e s o f f a i l u r e	O C C	Current Process controls	D E T	R P N	R A N K
1	Collect wheel nuts	Wheel nuts not available	Unable to attach wheels	5	Late delivery of parts	3	Kanban system	2	30	10
2				5	No parts available in stores	2	Min. 2 days stock in stores	3	30	10
3			Delay production of all vehicles on line	5	Late delivery of parts	3	Kanban system	2	48	4
4				5	No parts available in stores	2	Min. 2 days stock in stores	3	48	4
5		Wrong wheel nuts available	Damage to bolts	4	Incorrect indication of part number	1	Part numbers listed on storage boxes	5	20	14
6			Unable to attach wheels	5	Late delivery of parts	3	Kanban system	2	30	10
7				5	No parts available in stores	2	Min. 2 days stock in stores	3	30	10
8			Delay production of all vehicles on line	5	Late delivery of parts	3	Kanban system	2	48	4
9				5	No parts available in stores	2	Min. 2 days stock in stores	3	48	4
10	Collect tools to tighten nuts	Incorrect tools available	Damage to wheel nuts	3	Tool applies too much torque	5	None	5	120	2
11			Damage to wheel nuts	3	Tool head too big for nut	2	Other heads available at workbench	6	36	9
12			Delay production of all vehicles on line	5	Tool search delays production	3	Other heads available at workbench	6	144	1
13		Tools damaged	Unable to attach wheels	5	Tools dropped on floor	1	None	5	40	8
14				5	Tool head damaged	2	None	5	80	3
15										

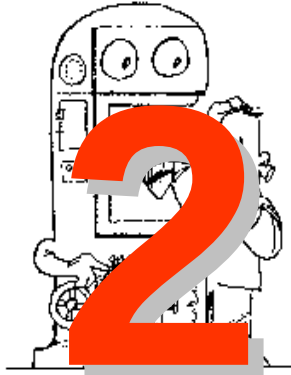
Step 4: Identify root cause(s)

The 5 why's



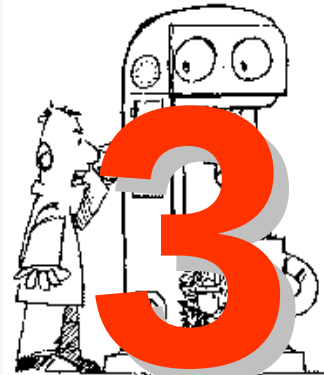
Q : **WHY** has machine stopped ?

A : Overload tripped out !



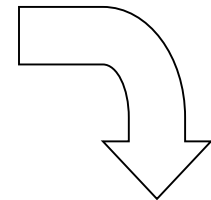
Q : **WHY** overload trip ?

A : Insufficient oil on shaft!



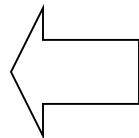
Q : **WHY** Insufficient oil ?

A : Oil pump is inefficient!



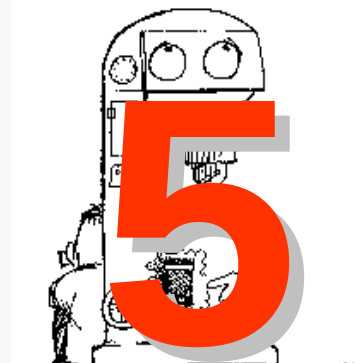
Is “Oil filter blocked with swarf”
the real root cause?

You should finish asking “Why?”
where you can launch actions to
fix the problem.



Q : **WHY** is pump not efficient ?

A : Pump drive shaft worn !

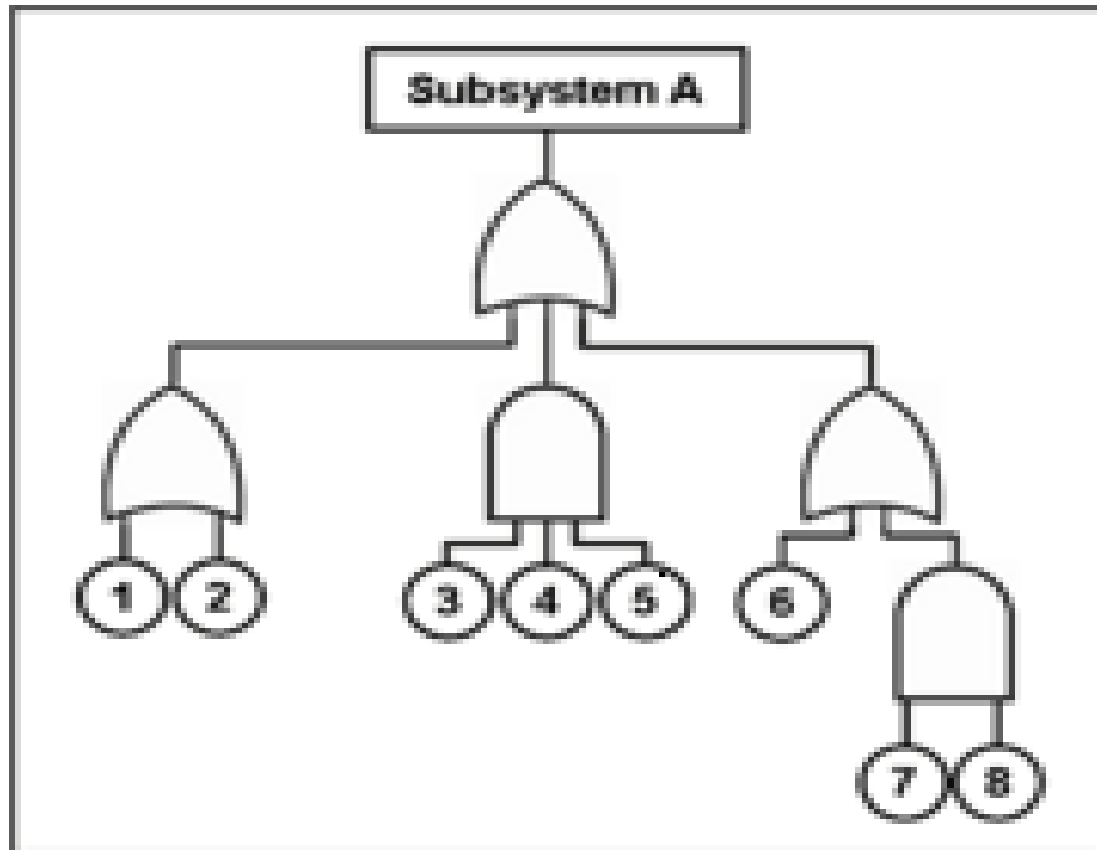


Q : **WHY** is this shaft worn ?

A : Oil filter blocked with swarf !

Step 4: Identify root cause(s)

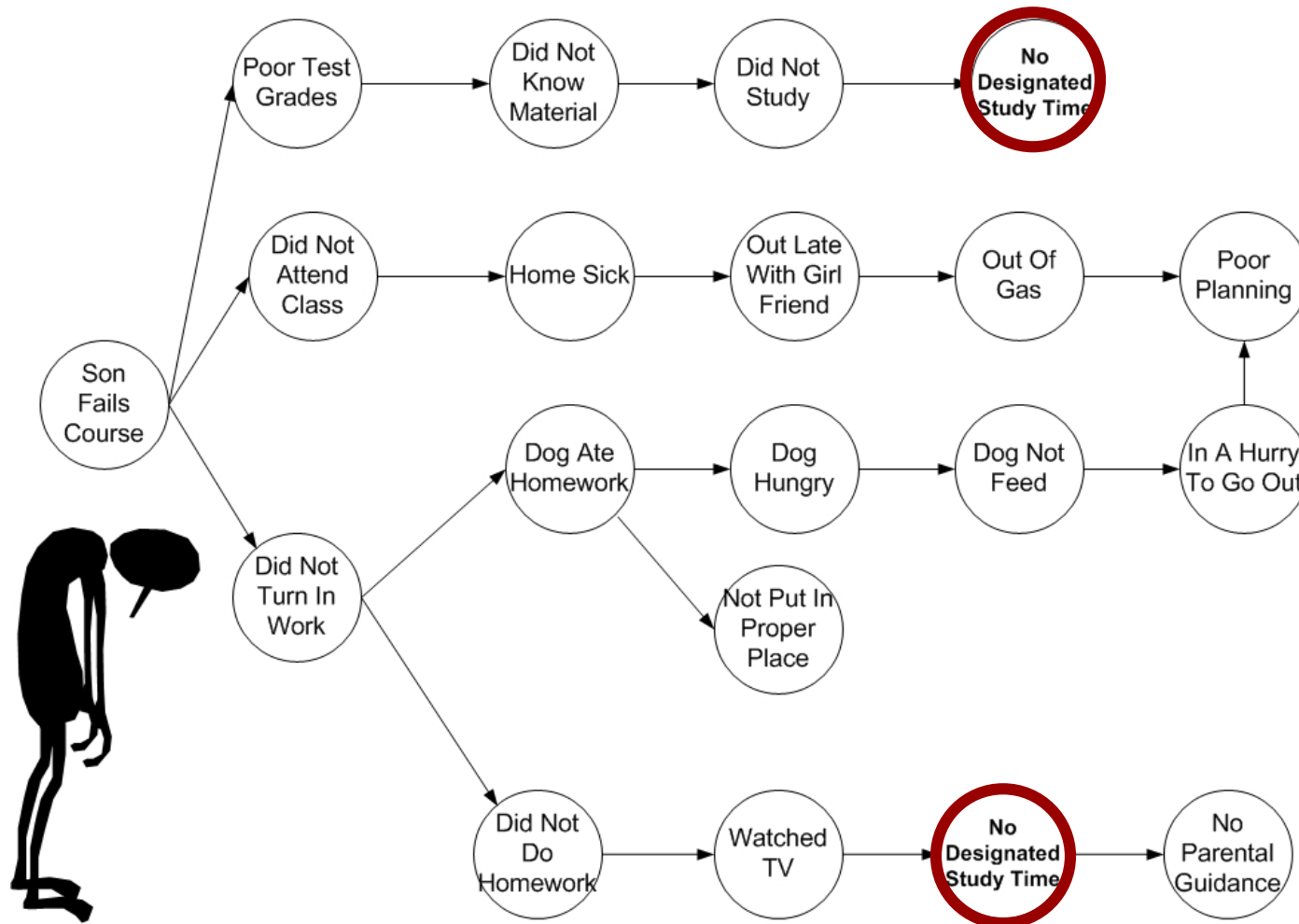
The Failure Tree Analysis is a failure analysis in which an undesired state of a system is analyzed to combine a series of lower-level events.



Step 4: Identify root cause(s)

The Root Cause Chain

Root Cause Chain Analysis



Step 4: Identify root cause(s)

- Common Causes (Environmental)
 - 85% of Variation (Many Small Problems)
 - Predictable
 - Difficult to Eliminate

85%

- Poor maintenance of machines
- Normal wear and tear
- Insufficient training
- Not one way of working
- Poor working conditions
- Measurement error
- Ambient temperature / humidity

- Special Causes (Assignable)
 - 15% of Variation (Few Large Problems)
 - Unpredictable
 - Easily Detected & Corrected

15%

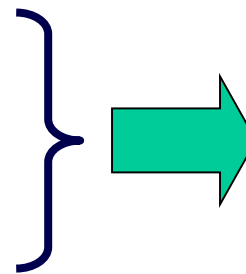
- Poor Batch of Material
- Inexperienced Operator
- Out of Date Drawings
- Tool Damage
- Maintenance Check overlooked
- Misread Drawing / Planning Instruction
- Machine Breakdown

Step 4: Identify root cause(s)

- Action Plan

- Eliminate Special Cause Variation

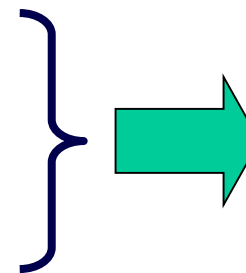
- Identify when it happens
 - Identify root causes
 - Eliminate root causes



Stabilize Process

- Reduce Common Cause Variation

- Identify amount of variation
 - Establish if it is excessive
 - Identify root causes



Control variations

Step 5: Define and select permanent corrective actions

- Objective: To define, prioritize and select corrective actions that must be implemented to address the root causes and permanently prevent the undesirable condition, situation, nonconformity or failure from recurring.
- Output: Permanent corrective actions defined
- WHAT: To ensure that corrective actions addressing the most likely or the most critical root causes and contributing causes are taken, considering operational and business constraints (costs, lead time, difficulty of implementation, resources) so that the undesirable condition, situation, nonconformity or failure will never reoccur
- WHY: Often the problem is not definitely solved because wrong actions are taken based on insufficient relation between the causes, the effects and the corrective actions.
- WHO: All the team members.

Step 5: Define and select permanent corrective actions

- WHEN: When all root and contributing causes have been identified and their effect understood
- HOW:
 - Based on results of risk analysis (Step 4 outcomes), identify solutions for each selected root cause
 - Determine for each solution :
 - The probability of correcting the cause
 - The risk of creating a new or worse problem
 - The difficulty of implementation (practicality, time scale, costs, return on investment, etc)
 - The stability over time
 - How to verify implementation and effectiveness
 - Clear ownership (in particular if they have to be implemented internally or externally)
 - Select solutions that optimize value and effectiveness for all stake holders

Step 5: Define and select permanent corrective actions

- **COMMUNICATION:**
 - Continual communication between all team members is mandatory, for instance through regular reviews until root cause corrective actions are clearly identified and agreed by all
 - Root causes corrective actions must be communicated to all stake holders and agreed, especially by the customer when he is impacted
 - Communication internally and between various tier levels
- **TO BE CONSIDERED:**
 - When contributing causes can be easily minimised or removed, documented action should also be taken to reduce their impact

Step 6: Implement permanent corrective actions and check effectiveness

- Objective: To ensure all selected actions are implemented as defined and to assess their effectiveness in permanently preventing the undesirable condition from recurring.
- Output: Permanent corrective actions implemented and efficiency demonstrated (problem prevented from reoccurring)
- WHAT: Implement the solutions that have been selected, verify that all actions have been completed to schedule and that they have prevented and will continue to prevent the undesirable condition, situation, nonconformity or failure from recurring
- WHY: Too often, at this step of the corrective action process, focus is only on the implementation of the easiest and quickest solutions and there is no plan to verify timely implementation of the actions and their overall effectiveness, resulting in corrective action plan to be only partially implemented.

Step 6: Implement permanent corrective actions and check effectiveness

- WHEN: As soon as actions have been prioritised and selected (i.e. when decision has been made to launch the plan) and until effectiveness has been demonstrated and agreed by all stake holders including the customer
- WHO: The owner of each action to implement it as defined and other team members including when relevant the customer, to verify effectiveness
- Note: At this stage, key role of team leader is to ensure that the entire corrective action plan (solutions) has been implemented in due time and is effective
- HOW:
 - Identify action owners (individuals, not functions) and due dates
 - Get commitment from all action owners and ensure they agree with the plan
 - Plan detailed actions (e.g. issue detailed working instructions, order parts or tools, etc...)

Step 6: Implement permanent corrective actions and check effectiveness

- HOW (continued)
 - Establish a review process to ensure actions are completed to the plan and will continue to be effective over time (e.g. by performing a product or process audit))
 - Process confirmation (confirming you have done what you have planned)
 - Definition of type and number or frequency of additional checks and audits
 - Identify measures required to verify effectiveness of actions (who, what, where, frequency, conditions,...)
 - Measure and analyse new performance as planned and compare results with performance measured at steps 2 and 4
 - Verify effectiveness of the solutions
 - If the root cause corrective action is not effective, return to step 4 (identify root causes) and revisit the analysis process to check if the failure was the root causes identification and/or the development of the solutions
 - If they are effective, evaluate which containment actions may be eliminated (e.g. stop over inspection and over production, return to normal transportation means, etc...) without adversely affecting the product and process output.

Step 6: Implement permanent corrective actions and check effectiveness

- HOW (continued)
 - Record evidence of actions completed and associated results (what works and what does not)
- COMMUNICATION:
 - Ensure feedback of all information between each action owner, the team leader and the customer as required
 - Content and frequency of reviews and status reports shall be defined between the team leader and the stakeholders
 - Escalation to management and the customer in case of implementation difficulties or failures
- TO BE CONSIDERED:
 - At this step, the team leader has to check that the composition of the team is still appropriate. It is likely that new members will be invited to join the team (new action owners, people in charge of implementing and verifying the effectiveness of the corrective actions, etc...) and some may leave.

Step 6: Implement permanent corrective actions and check effectiveness

- TO BE CONSIDERED (continued):
 - When actions have to be implemented/verified in other business areas, production lines, factories or suppliers, members of this organization shall become part of the team
 - Consideration should be made, when validating the improved process, to the way possible mistakes will or will not be detected.
 - Source detection: The process detects the error making it impossible to do wrong.
 - Self detection: The process points out the error during the operation.
 - Successive detection: A later process detects the error after the operation
 - Detection not possible further in the process (e.g. Special Process)

Step 7: Standardize and transfer the knowledge across business



- Objective: To document analysis, results and changes, to capture and share learning with all the stakeholders to prevent similar undesirable condition, situation, nonconformity or failure occurring on other products, production lines, factories or suppliers
- Output: Occurrence of similar problems prevented (system improved)
- WHAT: Formalise and standardise decisions made and actions completed throughout the whole process and develop effective knowledge management to transfer ideas, lessons learned, best practices, etc to all other stake holders and other similar production lines, factories or suppliers that may require similar actions to be implemented
- WHY: As product lines, people, processes and systems change, the same or similar issue will recur if introduced changes are not captured and frozen. Moreover, if an undesirable condition, situation, nonconformity or failure happened somewhere, it is very likely that it will also happen in a similar environment or on a similar or new product of the same nature.

Step 7: Standardize and transfer the knowledge across business



- WHO: The team leader and all team members with involvement and support of all levels of management
- WHEN: When actions have been successfully implemented and their effectiveness is demonstrated
- HOW:
 - Compile all documentation, instructions, analyses, flow charts, etc...
 - Ensure all working documentation (working and inspection instructions, purchase orders, etc...) is updated and available at every point of use
 - Update skills matrices, training packages and deploy training accordingly
 - Update IT systems and tools to support all design and process changes
 - Capture and share knowledge
 - Identify all other data, products, production lines, factories or suppliers that may potentially be affected by same type of undesirable condition, situation, nonconformity or failure (similar design, process, material source or supplier, location, function or use, environment, training, machines and tools)

Step 7: Standardize and transfer the knowledge across business



- HOW (continued):
 - Identify all what can be shared from your experience and can be transferred across these identified business units, production lines, factories or suppliers
 - Get agreement from appropriate levels of management and other process owners and functions (internally and externally) to launch actions and verify there are implemented and effective
 - Register lessons learned: Summary of content and results of analyses, flow charts, data bases, performance data, main actions and decisions, location where detailed data can be retrieved, difficulties encountered when managing the issue, etc...
- COMMUNICATION:
 - Inform all main process owners (internally and externally) of experience gained (what worked, what failed and the associated reasons)

Step 7: Standardize and transfer the knowledge across business



- COMMUNICATION (continued):
 - Ask or encourage all staff and all functions to cascade information, implement similar changes but checking possible adverse effects and develop training in their area of activity
- TO BE CONSIDERED:
 - When the decision is made to implement actions in other business areas, production lines, factories or suppliers, which are not under direct control of the team, implementation and the verification of effectiveness is not necessarily the responsibility of the team: Escalation to top management or transfer to another function (procurement, engineering, etc..) may be required to ensure proper leverage and action follow-up

Step 8: Recognize and close the team Celebrate!



- Objective: To ensure all team members and stakeholders are aware of the successful implementation of all actions, to confirm that the activity is closed, and to recognise and reward their work and accomplishment.
- Output: Synthesis of actions distributed and recorded, team acknowledged and Root Cause Analysis process closed
- WHAT: Confirm that all actions have been successfully implemented, record synthesis of causes, actions and methodology, inform all those having been affected by the undesirable condition, situation, nonconformity or failure that the activity is complete, recognize those who have been involved in the corrective action process and disband the team.
- WHY: Too often, action items are left open, diverting people from their main roles, closed loop corrective action process is not achieved because there is no feedback of actions and results to stake holders, and team efforts are not recognised which negatively affects the dynamics of the root cause corrective action culture.

Step 8: Recognize and close the team Celebrate!



- WHO: All the team and stake holders, especially the customer if he has been involved
- WHEN: When all corrective actions have been implemented and their effectiveness has been demonstrated internally and externally, and if relevant, when knowledge has been transferred to other business units, production lines, factories or suppliers.
- HOW:
 - Check that all steps and all actions have been completed, in particular that:
 - The undesirable condition, situation, nonconformity or failure has not recurred and there is a high level of confidence it will never do
 - All actions and decisions have been adequately documented and stored
 - Lessons learned have been reviewed, in particular the way the problem solving and root cause analysis processes were managed (successful actions and behaviour, possible mistakes to be avoided in the future, etc)

Step 8: Recognize and close the team

Celebrate!



- HOW (continued):
 - Ensure the customer has been informed and is satisfied by the final result
 - Recognise team, inform all members that the team is now disbanded, and celebrate success
- COMMUNICATION:
 - Last information must be ensured that may include:
 - Close out meeting
 - Sending complete dossier to stake holders and customer
 - Visual management board update

Step 8: Recognize and close the team

Celebrate!



- TO BE CONSIDERED
 - In some exceptional cases, it may happen that some actions are required in another business area, production line, factory or supplier, which are not under direct control of the team. In that case, the team activity can be closed and the team can be disbanded only if:
 - None of these actions are critical to the effectiveness of the corrective action plan
 - Proper information has been escalated to all stake holders
 - Decision to transfer implementation and the verification of effectiveness of remaining actions has been agreed by all, in particular by the organization to which the activity is transferred (ensure appropriate management level)
 - The appropriate management has acknowledged that the remaining activities are no longer the responsibility of the team

- For any question or comments, please contact:

IAQG SCMh TEAM at

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