“Supply Chain Management Handbook”

Control of non conformities, corrective and preventive actions

Root Cause Analysis and Problem Solving

Updated April 2008
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 right measures are taken at the right location and right time).
Rationale 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 are originated by small problems that were discovered but with incorrect analysis and/or reaction when identified.
  – Major companies have their own structured system, but small companies have not.
  – A comparison between these various processes and evaluation of commonalities/particularities has never been done.

• Study should include how to improve communication of information between all stakeholders (engineering, MRB, supplier, customer, etc...) when a problem arises to ensure right measures are taken at right location and right time
Situation today

• Our suppliers (and even some times or organisation) do not deliver correct Root Cause Analysis and Problem Solving results

• Reasons
  – We have not set criteria about what makes an acceptable corrective action plan (we are satisfied when we don’t receive any more defective parts and stop here)
  – We continue to accept bad answers (even if say we will not, reality of life makes us accepting)
  – People (internal and external) have not the Root Cause Analysis culture, don’t know any process or are not effectively trained

• Cultural change required to overcome the situation
Benefits of effective Corrective Action process (Brainstorming)

- 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 image
- Objective evidence for evaluation of corrective action effectiveness
- 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 organisation (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)
Risks and impacts of not having an effective corrective action process (Brainstorming)

- 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
- 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)
  - 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)
Key factors of success (Brainstorming)

• 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)
• Identify solution
• Implement solution
• Verify effectiveness of the solution
• 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 buying into the whole corrective action process is a Must
3 Problem Solution Types

- **Reactive mode**
  Solving the abnormality that has occurred, gathering and analysing data aims to provide a customer protection and countermeasure.

- **Pro-active mode:**
  Analysing failures and looking for improvements.

- **Preventive mode:**
  Putting in place solutions before undesirable condition, defect or failure occur.
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 organisation 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

• **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 proposed by the team

- **Nonconformity**: Non-fulfillment of a requirement.

  *Note: It may be a non conforming product but also a late delivery, an incorrect paperwork, incorrect process, etc…*

- **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*
Terminology: New definitions proposed by the team (continued)

- **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.

- **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 proposed by the team (continued)

- **Immediate Correction**: Action(s) taken to fix the nonconformity.
  - Note: For a product nonconformity, 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 proposed by the team (continued)

- **Root Cause Corrective Action:** The corrective action(s) implemented to address the root cause(s) of the nonconformity that will prevent recurrence.

- **Root cause 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.

- **Root cause 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 the team members’ company methodologies

<table>
<thead>
<tr>
<th>7-Step</th>
<th>8D</th>
<th>MTU &amp; Airbus - 8D</th>
<th>Boeing model</th>
<th>Rolls-Royce 7 Step</th>
<th>Safran Impact 8D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Select project/theme</td>
<td>1. Identify team</td>
<td>0. Immediate containment</td>
<td>Correct, Contain, Communicate</td>
<td>1. Define Problem</td>
<td>0. Define the problem and make sure that the methodology is necessary</td>
</tr>
<tr>
<td>2. Grasp present status</td>
<td>2. Define problem</td>
<td>1. Identify team</td>
<td>Corrective Action</td>
<td>2. Contain problem</td>
<td>1. Build the team</td>
</tr>
<tr>
<td>8. Recognise the team</td>
<td>8. Recognise the team</td>
<td></td>
<td></td>
<td></td>
<td>7. Capitalize, perpetuate, generalize to avoid problem’s recurrence</td>
</tr>
</tbody>
</table>

**Boeing model**
- **Correct, Contain, Communicate**
- **Corrective Action**
- **Root Cause Corrective Action**
- **Root Cause Corrective Action Follow Up**

**MTU & Airbus - 8D**
- **Correct, Contain, Communicate**
- **Corrective Action**
- **Identify Root Cause**
- **Root Cause Corrective Action Verification**

**Rolls-Royce 7 Step**
- **Define Problem**
- **Contain problem**
- **Find root cause of escape**
- **Prevent further escapes**
- **Find root cause of problems**
- **Implement corrective action**
- **Verify fix**

**Safran Impact 8D**
- **Define the problem and make sure that the methodology is necessary**
- **Build the team**
- **Describe problem**
- **Define and launch temporary actions to contain the risks**
- **Find the root causes**
- **Find and grade corrective actions**
- **Do corrective actions and make sure they are efficient**
- **Capitalize, perpetuate, generalize to avoid problem’s recurrence**
- **Conclude the process and congratulate the team**
Process Steps

Immediate correction and containment actions

Build the team

Define problem

Find why problem was not detected

Contain symptom

Identify Root Cause(s)

Define and prioritise corrective actions

Implement corrective actions

Verify Corrective Actions are effective

Make change permanent and transfer the knowledge

Recognise the team

Start Immediate containment actions

Build the team

Define problem

Complete and optimise containment actions

Identify Root Cause(s)

Define and select root cause corrective actions

Implement root cause corrective actions and check effectiveness

Standardise and transfer the knowledge across business

Recognise and close the team

Is the root cause corrective action effective?

yes

no
Process Steps

**S0**
Start Immediate containment actions

**S1**
Build the team

**S2**
Define problem

**S3**
Complete and optimise containment actions

**S4**
Identify Root Cause(s)

**S5**
Define and select root cause corrective actions

**S6**
Implement root cause corrective actions and check effectiveness

**S7**
Standardise and transfer the knowledge across business

**S8**
Recognise and close the team

Time relationship between steps shall be defined by the type and criticality of the problem and by contractual requirements.
When to launch a structure 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
  - High impact on operations
    - Stop the line, prevent next operations to occur satisfactorily, etc
    - Regulatory authorities and/or customer dissatisfaction
    - Costs issue
  - Repetitive problems (on one part, similar activity or similar process)
  - Difficulty to detect
  - Customer request
When to launch a structure root cause analysis and problem solving process?

Customer request shall always take precedence

- Not required
- Optional
- Recommended
- Mandatory

Impact

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

- **Objective:** To mitigate the impact of the problem, protect the customer operations and the organisation (stop the problem getting worse) and verify that problem does not degrade until the root causes are known.

- **WHAT:** First thought “What do we have to do to protect the Customer and the organisation (eliminating the impact of the effect)”?

- **WHY:** The problem that has been identified is having an impact now on the customer or on the organisation. If we don’t do anything, the problem will degrade: This justifies a containment plan.

- **WHEN:** Action generally required within 24 hours (or 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 organisation or already delivered)
    • Over inspection - “Build the wall higher”
  - 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 organisations.
  - Identify who is affected by the issue and if he is or when he will be impacted
  - 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, 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, 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 (organisation, 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
  - **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 than by individuals.
  - **WHO:**
    - Top management must support the team approach to the corrective action process
    - Team leader (facilitator) shall be nominated
      - Should not be necessarily be an expert in the processes/problems being analysed, but preferably be an expert in problem solving. He should have preferably 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 his/her experience of root cause analysis techniques or will get the appropriate help by specialists
Step 1: Build the team

- 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

- HOW:
  - Identify representatives from functions that may have an influence on the corrective action process, including identification of the root causes (see table)
  - Assign responsibilities and objectives

Notes:
- Remember, those performing the job (Operators, inspectors, drivers, 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 expending 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, 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.

<table>
<thead>
<tr>
<th></th>
<th>Sees the problem</th>
<th>Suffers from the problem</th>
<th>Is in charge of solving the problem</th>
<th>Could help solving the problem</th>
<th>Could contribute to the problem</th>
<th>Will help selecting solution</th>
<th>May be impacted or disturbed by the fixing of the problem</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 his/her ability to effectively manage team dynamics:

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

- 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

- WHO: All the team

- 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

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 well 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 defective? When is the problem repaired?
  – 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, …)

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!

Symptoms

Problems

EFFECT

CAUSES

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
    – 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).

<table>
<thead>
<tr>
<th>Problem Profile</th>
<th>IS</th>
<th>IS NOT</th>
<th>Gather Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What Object</td>
<td>Pacific Engine Covers</td>
<td>Asbestos engine covers</td>
<td></td>
</tr>
<tr>
<td>2. What Defect</td>
<td>Gaps in paint due to poor paint adhesion</td>
<td>Part peeling/Flaking/Blistering/numerals/scratch/scratches/erosion/minute abnormalities/full coating</td>
<td></td>
</tr>
<tr>
<td>3. Where Seen Geographically or component</td>
<td>Randomly on surface</td>
<td>In a specific area</td>
<td></td>
</tr>
<tr>
<td>4. When First Observed</td>
<td>Final inspection area</td>
<td>Spray booth/assembly area/customer</td>
<td></td>
</tr>
<tr>
<td>5. Where Seen Since</td>
<td>At the ERA in the inspection area</td>
<td>Final inspection/customer's despatch</td>
<td></td>
</tr>
<tr>
<td>6. When First Seen</td>
<td>A few days before the 24th of May, in the inspection area</td>
<td>Prior to 2 weeks ago, after shipping</td>
<td></td>
</tr>
<tr>
<td>7. What Pattern Since</td>
<td>In batches at regular intervals</td>
<td>Continuous, sporadic</td>
<td></td>
</tr>
<tr>
<td>8. How Many affected?</td>
<td>6% (4.5% above normal rate)</td>
<td>More or less than 6%</td>
<td></td>
</tr>
<tr>
<td>9. What Size</td>
<td>Random sized defects</td>
<td>Specific size</td>
<td></td>
</tr>
<tr>
<td>10. Defects per Part</td>
<td>1 - 10 defects/part</td>
<td>Not more than 10 defects/part</td>
<td></td>
</tr>
<tr>
<td>11. What is the trend?</td>
<td>Stable</td>
<td>Increasing or decreasing</td>
<td></td>
</tr>
</tbody>
</table>
The check sheet and the Tally chart

<table>
<thead>
<tr>
<th>CLASS</th>
<th>TALLY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.13</td>
<td>I</td>
<td>1</td>
</tr>
<tr>
<td>7.12</td>
<td>III</td>
<td>3</td>
</tr>
<tr>
<td>7.11</td>
<td>IIII</td>
<td>8</td>
</tr>
<tr>
<td>7.10</td>
<td>III  III</td>
<td>13</td>
</tr>
<tr>
<td>7.09</td>
<td>III  III</td>
<td>18</td>
</tr>
<tr>
<td>7.08</td>
<td>III  III</td>
<td>25</td>
</tr>
<tr>
<td>7.07</td>
<td>III  III</td>
<td>18</td>
</tr>
<tr>
<td>7.06</td>
<td>IIII</td>
<td>13</td>
</tr>
<tr>
<td>7.05</td>
<td>III</td>
<td>8</td>
</tr>
<tr>
<td>7.04</td>
<td>III</td>
<td>3</td>
</tr>
<tr>
<td>7.03</td>
<td>I</td>
<td>1</td>
</tr>
</tbody>
</table>
Step 2: Define problem
Go - Look - See

The Pareto chart
Step 2: Define problem

Go - Look - See

The Run chart

Run Chart to monitor the distance in mm between
Widget A and Widget B

Distance between widgets

Time

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Drill bit broke
Drill bit broke

Jig recalibrated

Target value
Step 2: Define problem
Go - Look - See

The control chart

1. Distance between Widgets - X Bar

1. Distance Between Widgets - Moving Range
Step 2: Define problem

Go - Look - See

The histogram

Number of Concessions / product between wk 01/02 & wk 36/02

Frequency

Concessions/product

- 6 - 9
- 9 - 12
- 12 - 15
- 15 - 18
- 18 - 21
- 21 - 24
Step 2: Define problem
Go - Look - See

The scatter diagram (shows relationships and how variables correlate)

- **Strong, positive relationship**
- **Strong, negative relationship**
- **Weak, positive relationship**
- **Weak, negative relationship**
- **No relationship**
Step 3: Complete and optimise containment actions

• **Objective:** To ensure containment actions suitably address the problem definition and to verify that immediate corrective actions are commensurate to the problem, implemented and effective

• **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 organisation 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

• **WHO:** The owner of each action and all team members to verify effectiveness of actions taken to date
Step 3: Complete and optimise containment actions

• **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, addition containment actions may include:
    • Over production
    • Over inspection upstream in the process
    • Stock segregation in sub-tiers
    • Similar product recall (still within the organisation or already delivered)

*Note:* Customer might be internal or external customer
Step 3: Complete and optimise 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 stakeholders and agreed, especially by the customer if some product has been delivered and/or if he might soon be impacted (e.g. delivery will stop)

• TO BE CONSIDERED:
  – Find why problem was not detected and take immediate corrective measures
  – 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 containment actions

• TO BE CONSIDERED (continued):
  – Find why problem was not detected and take immediate corrective measures
  – How are finished products in stores, WIP, at suppliers and customers being managed?
  – What is the estimated date for permanent root cause resolution? (The answer to this question may have an impact on the temporary measures).
  – How do you manage communication and action implementation across various entities and organisations?

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.

- DEFINITIONS:
  - **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.
  - **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.
  - **Root Cause Analysis:** 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.
Step 4: Identify root cause(s)

• **WHAT:** To follow a structured process to identify all causes that when addressed by appropriate corrective actions, will durably prevent the undesirable condition, situation, nonconformity or failure from recurring.

• **WHY:** No problem can be effectively and durably 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

• **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
Step 4: Identify root cause(s)

• HOW:
  • Prioritise causes by performing a risk analysis based on:
    • Impact on the product, operations, customer, etc
    • Probability to occur
    • Detectability

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

• 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 stakeholders and agreed, especially by the customer when he is impacted.
  • Communication internally and between various tier levels
Step 4: Identify root cause(s)

• TO BE CONSIDERED:
  • What course will the root cause analysis take i.e. what are the investigations to be undertaken?
  • 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

• TOOLS:
  • Some tools must be used which enable problems to be defined, data to be collected and analysed
Step 4: Identify root cause(s)

• Tools to be used in step 4 (see also step 2 “Define Problem “as some are common to both steps):

<table>
<thead>
<tr>
<th>Checksheets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Histograms</td>
</tr>
<tr>
<td>Scatter Diagrams</td>
</tr>
<tr>
<td>Run and Control Charts</td>
</tr>
<tr>
<td>Process mapping (Flow Charts)</td>
</tr>
<tr>
<td>Design of Experiment</td>
</tr>
<tr>
<td>Pareto Analysis</td>
</tr>
<tr>
<td>Fishbone</td>
</tr>
<tr>
<td>5 Why</td>
</tr>
<tr>
<td>Cause and effect</td>
</tr>
<tr>
<td>FMEA (Failure Mode and Effect Analysis)</td>
</tr>
</tbody>
</table>

Data Collection

Data Collection & Analysis

Analysis Techniques
Step 4: Identify root cause(s)

Skin Installation Process

Start

Load Skins in Racks

Inspected: Correct?

Yes

Install in Jig and Drill

No

Return for Rework

Apply Spray Dot

Drill Identification Holes

Manual Rivet, Identify and Mark

Trim, Remove Lug, Deburr, Clean and Apply Sealing

Yes

Checked Prior to Trim: Correct?

No

Fastener Bracket Installation

Automatic Riveting

Applying Liquid Shim

Final Drill, Countersink

Yes

Inspected: Correct?

No

Clean, Identify Scratch Repair

End

Ship to Next Step

Return for Rework

Yes

Correct?
Step 4: Identify root cause(s)
## Step 4: Identify root cause(s)

### FMEA (Failure Mode and Effect Analysis)

<table>
<thead>
<tr>
<th>Number</th>
<th>Process Step</th>
<th>Potential Failure Mode</th>
<th>Potential Failure Effect</th>
<th>Potential Causes of failure</th>
<th>Current Process controls</th>
<th>DET</th>
<th>RPN</th>
<th>RANK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Collect wheel nuts</td>
<td>Wheel nuts not available</td>
<td>Unable to attach wheels</td>
<td>Late delivery of parts</td>
<td>Kanban system</td>
<td>2</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>No parts available in stores</td>
<td>Min. 2 days stock in stores</td>
<td>3</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>Late delivery of parts</td>
<td>Kanban system</td>
<td>2</td>
<td>48</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>No parts available in stores</td>
<td>Min. 2 days stock in stores</td>
<td>3</td>
<td>48</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Wrong wheel nuts available</td>
<td>Damage to bolts</td>
<td>Incorrect indication of part number</td>
<td>Part numbers listed on storage boxes</td>
<td>5</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>Late delivery of parts</td>
<td>Kanban system</td>
<td>2</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>No parts available in stores</td>
<td>Min. 2 days stock in stores</td>
<td>3</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Delay production of all vehicles on line</td>
<td>Late delivery of parts</td>
<td>Min. 2 days stock in stores</td>
<td>Kanban system</td>
<td>2</td>
<td>48</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>No parts available in stores</td>
<td>Min. 2 days stock in stores</td>
<td>3</td>
<td>48</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>Collect tools to tighten nuts</td>
<td>Incorrect tools available</td>
<td>Damage to wheel nuts</td>
<td>Tool applies too much torque</td>
<td>None</td>
<td>4</td>
<td>120</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Damage to wheel nuts</td>
<td>Tool head too big for nut</td>
<td>Other heads available at workbench</td>
<td>6</td>
<td>36</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Delay production of all vehicles on line</td>
<td>Tool search delays production</td>
<td>Other heads available at workbench</td>
<td>4</td>
<td>144</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Tools damaged</td>
<td>Unable to attach wheels</td>
<td>Tools dropped on floor</td>
<td>None</td>
<td>4</td>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td>Tool head damaged</td>
<td>None</td>
<td>None</td>
<td>1</td>
<td>80</td>
<td>3</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Step 4: Identify root cause(s)

The 5 why’s

Q: WHY has machine stopped?
A: Overload tripped out!

Q: WHY overload tripped?
A: Insufficient oil on shaft!

Q: WHY Insufficient oil?
A: Oil pump is inefficient!

Q: WHY is pump not efficient?
A: Pump drive shaft worn!

Q: WHY is this shaft worn?
A: Oil filter blocked with swarf!

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

You should finish asking “Why?” where you can launch actions to fix the problem.
Step 4: Identify root cause(s)

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

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

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

- **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
  - Reduce Common Cause Variation
    - Identify amount of variation
    - Establish if it is excessive
    - Identify root causes

Stabilise Process
Control variations
Step 5: Define and select root cause corrective actions

• Objective: To define, prioritise and select corrective actions that must be implemented to address the root causes and prevent the undesirable condition, situation, nonconformity or failure from recurring.
• WHAT: To ensure most effective corrective actions addressing the most likely or critical root causes are taken, considering operational and business constraints (costs, lead time, difficulty of implementation, resources)
• WHY: Often the problem is not durably solved because wrong actions are taken based on insufficient relation between the causes, the effects and the corrective actions.
• WHO: All the team members.

WHEN: When all root and contributing causes have been identified and their effect understood
Step 5: Define and select root cause corrective actions

HOW:

- Based on results of risk analysis, identify solutions for each 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 optimise value and effectiveness for all stakeholders
Step 5: Define and select root cause 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 stakeholders 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 root cause corrective actions and check effectiveness

- **Objective:** To implement all selected actions, verify that the planned actions were taken as scheduled and assess their effectiveness in permanently preventing the undesirable condition, situation, nonconformity or failure from recurring.

- **WHAT:** Implement the solutions that have been selected, verify that all actions have been completed to schedule and that they have prevented 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 solutions and there is no plan to verify the overall effectiveness of the actions, resulting in corrective action plan to be partially implemented only.

- **WHO:** The owner of each action, the team leader and all team members to verify effectiveness of actions taken to date, and when relevant, the customer.

**Note:** At this stage, key role of team leader is to ensure that the corrective action plan (solutions) has been implemented in due time and is effective.
Step 6: Implement root cause 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 stakeholders including the customer

• **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…)
  - Establish a review process to ensure actions are completed to the plan and will continue to be effective over time
    - Process confirmation (confirming you have done what you have planned)
    - 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
Step 6: Implement root cause corrective actions and check effectiveness

• HOW (continued)
  • 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.
  • 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 periodicity of reviews and status reports shall be defined between the team leader and the stakeholders
  • Escalation to the management and the customer in case of implementation difficulties or failures
Step 6: Implement root cause corrective actions and check effectiveness

• TO BE CONSIDERED:
  • When same problem has been identified or is suspected to occur on same or similar products, processes or data, same corrective actions must be implemented and their effectiveness verified for all these products, processes or data.
  • 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 7: Standardise and transfer the knowledge across business

- **Objective:** To document analysis results and changes to make the corrective action permanent, 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.

- **WHAT:** Formalise and standardise decisions made and actions completed throughout the whole process and develop an effective organisational memory (knowledge management) to effectively transfer ideas, lessons learned, best practices, etc to all other stakeholders 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 any similar environment or on a similar or new product of the same nature.
Step 7: Standardise 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…) are updated and relevant documentation is made available at every point of use
  - Update skills matrices, training packages and deploy trainings 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: Standardise 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
  • Keep lessons learned register: 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)
  • 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
Step 7: Standardise and transfer the knowledge across business

• TO BE CONSIDERED:
  • When the decision is made to implement actions in another business area, 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: Recognise and close the team Champagne!

- Objective: To ensure all team members and stakeholders are aware of the successful and effective implementation of all actions, to recognise and reward their work and accomplishment and to confirm that the activity is closed.
- WHAT: Confirm that all actions have been successfully implemented, 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 stakeholders, and team efforts are not recognised which negatively affects the dynamics of root cause corrective action culture.
Step 8: Recognise and close the team Champagne!

- **WHO:** All the team and stakeholders, 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 filed.
    - Lessons learned have been reviewed, in particular the way the problem solving and root cause analysis processes were managed.
  - 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.
Step 8: Recognise and close the team 

Champagne!

• COMMUNICATION:
  • Last information must be ensured that may include:
    • Close out meeting
    • Sending complete dossier to stakeholders and customer
    • Informal or formal ceremony
    • Visual management board update

• 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, the team activity can be closed and the team can be disbanded when:
    • Proper information has been escalated to top management
    • Decision to transfer implementation and the verification of effectiveness of remaining actions to another function (procurement, engineering, etc..) has been agreed by all
    • The appropriate management has acknowledged that the remaining activities are no longer the responsibility of the team
Contact

• For any question or comment, please contact:

bernard.lauras@airbus.com