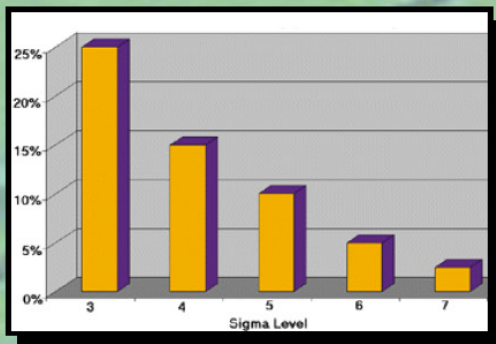
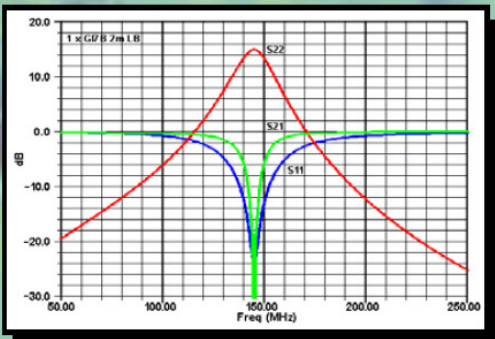


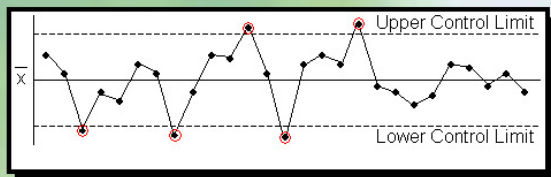
# Supplier Quality Assurance Supply Chain Management Quality Toolbox Tools and Techniques



LEAN MANUFACTURING  
7D CORRECTIVE ACTION  
CAUSE AND EFFECT  
CONTROL CHART



KAIZEN  
SIX SIGMA  
5S



Measuring Continuous  
Improvement



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In an effort to provide high quality, low cost products and services that meet and exceed our customer’s expectations General Dynamics Land Systems (GDLS) Supplier Quality Assurance has developed the Supplier Quality Tool Box. It can be found at [www.gdls.com](http://www.gdls.com), Procurement Home Page.

It is the intent of this booklet to introduce, to the Supply Chain, various quality concepts and techniques that will assist in reducing variation and waste in your Products and Services by better controlling and standardizing your processes.

## **Definitions:**

The objective of **Lean Manufacturing** is to minimize the waste endemic in this increasingly complicated world of manufacturing and thus improve competitive performance.

**5S** – a methodology for organizing, cleaning, developing, and sustaining a productive work environment.

**Batch size Reduction** – a manufacturing approach that emphasizes the reduction in process batch sizes by eliminating the system constraints that force large batch sizes.

**Cellular Manufacturing** – a manufacturing approach in which equipment and workstations are arranged to facilitate small-lot, continuous-flow production

**Cross Training** – a management approach in which multiple employees are trained to perform each production task, thereby eliminating skills monopolies.

**External Set Up Time** – time spent converting from one product setup to another while production is in progress.

**Gantt Chart** – a chart of events showing both duration and sequence.

**Internal Set Up Time** – time spent converting from one product production setup to another while production is halted.

**Job Shop** – a facility that has no product line of its own but simply sells its manufacturing capacity on an as needed job-by-job basis.

**Kaizen** – Japanese for “Continuous Improvement” – a management philosophy emphasizing employee participation, in which every process is continuously evaluated and re-evaluated for the elimination of waste.

**Kanban** – Pull Scheduling combined with traveling instructions conveyed by simple visual devices.

**Poka Yoke** – Japanese for “error proof” – A quality improvement strategy emphasizing preventing defects through the selection of low defect rate design options.

**Quality at the Source** – a Quality Assurance Philosophy that places responsibility for meeting customer specifications and standards at the point of manufacture.

**Repair** – actions required to bring products into compliance with deviated specifications

**Rework** – actions required to bring products into compliance with specifications.

**Standardized Work** – the process of documenting and standardizing tasks throughout the value stream.

**Value Stream** – all actions (both value added and non-value added) required to bring a specific product or service from raw material to the possession of the customer.

**Value Stream Mapping** – the process of identifying and charting the flows of: information, processes and physical goods across the entire supply chain from the raw material supplier to the possession of the customer.

**Visual Management** – the strategy of providing visual information on daily activities or information flows.

**Waste** – non-value adding activities or information flows (cost without compensating benefit)

## **Lean Manufacturing:**

### **A Simple Definition**

Lean Manufacturing is simply a group of Strategies for the Identification and Elimination of the Waste inside the Value Stream.

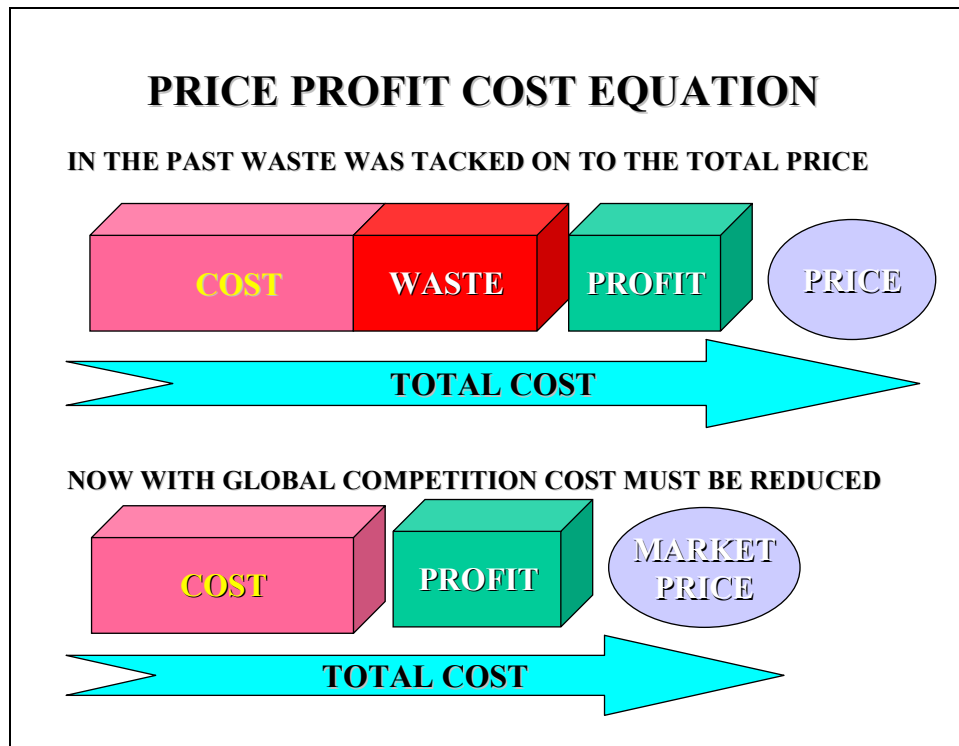
### **The Three Pillars:**

- The Problem – Waste exists at all levels and in all activities
- The Solution – The Identification and Elimination of waste
- The Who – All of the employees and departments compromising the organization

### **Seven Types of Waste**

<b><u>#</u></b>	<b><u>Name</u></b>
1.	Over-production
2.	Wait Time
3.	Transportation
4.	Processing
5.	Inventory
6.	Motion
7.	Defects

## Types of Waste



## Over-Production Waste

**Definition** – producing more than is needed, faster than needed or before needed

### **Characteristics:**

- Idle Operator waiting for Equipment
- Lack of Operator Concern for Equipment Breakdowns
- Production Bottlenecks
- Production Waiting for Operators
- Unplanned Equipment Downtime

### **Causes:**

- Inconsistent Work Methods
- Lack of Proper Equipment/Materials
- Long Setup Times
- Low Man/machine Effectiveness
- Poor Equipment Maintenance
- Production Bottle Necks
- Skills Monopolies

## Transportation Waste

**Definition** – any material movement that does not directly support immediate production

**Characteristics:**

- Endless Product/Process Refinement
- Excessive Copies/Excessive Information
- Process Bottlenecks
- Redundant Reviews and Approvals
- Unclear Customer Specifications

**Causes:**

- Decision Making at Inappropriate Levels
- Inefficient Policies and Procedures
- Lack of Customer Input Concerning Requirements
- Poor Configuration Control
- Spurious Quality Standards

## Inventory Waste

**Definition** – any supply in excess of process requirements necessary to produce goods or services in a Just-in-Time Manner

**Characteristics:**

- Additional Material Handling Resources (Men, Equipment, Racks, Storage Space)
- Extensive Rework of Finished Goods
- Extra Space on Receiving Docks
- Long Lead Times for Design Changes
- Storage Congestion Forcing LIFO (Last In First out)  
Instead of FIFO (First In First Out)

**Causes:**

- Inaccurate Forecasting Systems
- Incapable Processes
- Incapable Suppliers
- Local Optimization
- Long Change Over Times
- Poor Inventory Planning
- Poor Inventory Tracking
- Unbalanced Production Processes

## **Motion Waste**

**Definition** – any movement of people which does not contribute added value to the product or service

### **Characteristics:**

- Excess Moving Equipment
- Excessive Reaching or Bending
- Unnecessarily Complicated procedures
- Excessive Tool gathering
- Widely Dispersed Materials/Tools/Equipment

### **Causes:**

- Ineffective Equipment, Office and Plant Layout
- Lack of Visual Controls
- Poor Process Documentation
- Poor Work Place Organization

## **Defect Waste**

**Definition** – repair or rework of a product or service to fulfill customer requirements as well as scrap waste resulting from materials deemed to be un-repairable or un-reworkable

### **Characteristics:**

- Complex Material Flows
- Excess Finished Goods Inventory
- Excessive Floor Space/Tools/Equipment
- Excessive Manpower to Inspect/Rework/repair
- High Customer Complaints/returns
- High Scrap Rates
- Poor Production Schedule Performance
- Questionable Quality
- Reactive Organization

### **Causes:**

Excessive Variation

- High Inventory Levels
- Inadequate Tools/Equipment
- Incapable/Incompatible Processes
- Insufficient Training
- Poor Layouts/Unnecessary Handling (Transport Damage)



## **The Four Categories of Quality Costs**

- **Prevention**
  - *costs of activities designed to prevent poor quality*
- **Appraisal**
  - *costs associated with evaluating to standards*
- **Internal failure**
  - *costs to fix defects before the product is shipped*
- **External failure**
  - *costs to fix defects after the product is shipped*

**Quality costs result from not doing it right the first time**

## **Strive for Perfection - OR ELSE!**

**If 99.9% is good enough, then...**

•Two million documents will be lost by the IRS this year.

•22,000 checks will be deducted from the wrong bank account in the next 60 minutes.

•12 babies will be given to the wrong parents each day.

•Two plane landings at O'Hare International Airport will be unsafe.

•18,322 pieces of mail will be mishandled in the next hour.

•291 pacemaker operations will be performed incorrectly this year.

•14,208 defective personal computers will be shipped this year.

•1,314 phone calls will be misplaced by telecommunication services every minute.

•107 incorrect medical procedures will be performed by the end of today.

•315 entries in Webster's new international dictionary will turn out to be misspelled.

## Quality at the Source

**Definition** – a quality philosophy that places the responsibility for meeting customer specifications and standards at the point of manufacture

### **Approaches:**

1. Source inspection for purchased components
2. Operators self-inspect their work as well as inspecting (and/or rejecting) the work of previous operators
3. Poka -Yoke designed manufacturing devices, processes and products

## Poka -Yoke

**Definition** – a design approach to quality that places the responsibility for preventing defects within the design of the product and/or production process.

### **Approaches:**

**Design** – Within the product design specifications replace those specs which require defect prone processes/components with those that require non-defect prone processes/components

**Process/Fixture** – Within manufacturing replace those processes/fixtures which are defect prone with those that are not.

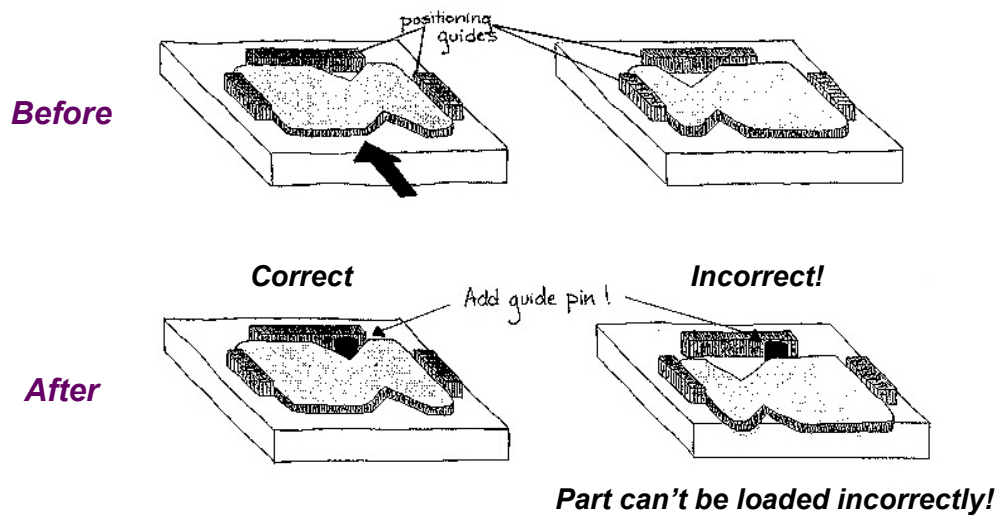
## Poka-yoke Characteristics

- **Goals and reasons for installation are clear**
- **Effective against recurrence – never malfunctions**
- **Stops flow without making, sending, or missing non-conforming material**
- **Costs little or no money**
- **Made with shop floor wisdom and ingenuity**
- **Simple, durable, and easy to maintain**
- **Can be widely used in other processes**
- **Does not impair operability**
- **Operator fully trained**

## Poka-yoke



- **Prevents making defective products**
- **Prevents sending defective products to the next operation**
- **Brings defective products to the surface**



## 5S (Workplace Organization)

### WHY 5S?

- Eliminate wastes that result from uncontrolled processes
- Gain control on equipment, material, and inventory
- Apply control techniques to eliminate erosion of improvements
- Standardize improvements for maintenance
- Improve delivery consistency
- Improve quality
- Improve safety
- Improve reliability

**Definition** – a methodology for organizing, clearing, developing, and sustaining a productive work environment

**Sort** – Get rid of clutter – Items which are not used in work area should be removed - Items frequently used should be properly identified and stored out of sight.

**Set In Order** – Organize the work area – A place for everything and every thing in its place - All production items and their storage locations should be clearly identified – accessibility should be prioritized with reference to use – cleaning materials/utensils must be stored in the work area – the sharing of cleaning materials/utensils between work areas should be discouraged.

**Shine** - Clean and Buff up the work area – It is essential that enough attention be paid to the neatness of work stations so that the workers will be able to take pride in ownership

**Standardize** – Establish written standards for order and cleanliness – specific time should be reserved for cleaning work stations (end of day and/or end of task)

**Sustain** – Maintain the standards through training, empowerment, commitment and discipline

#### **Benefits:**

Employee Ownership of Workspace

Improved Maintenance

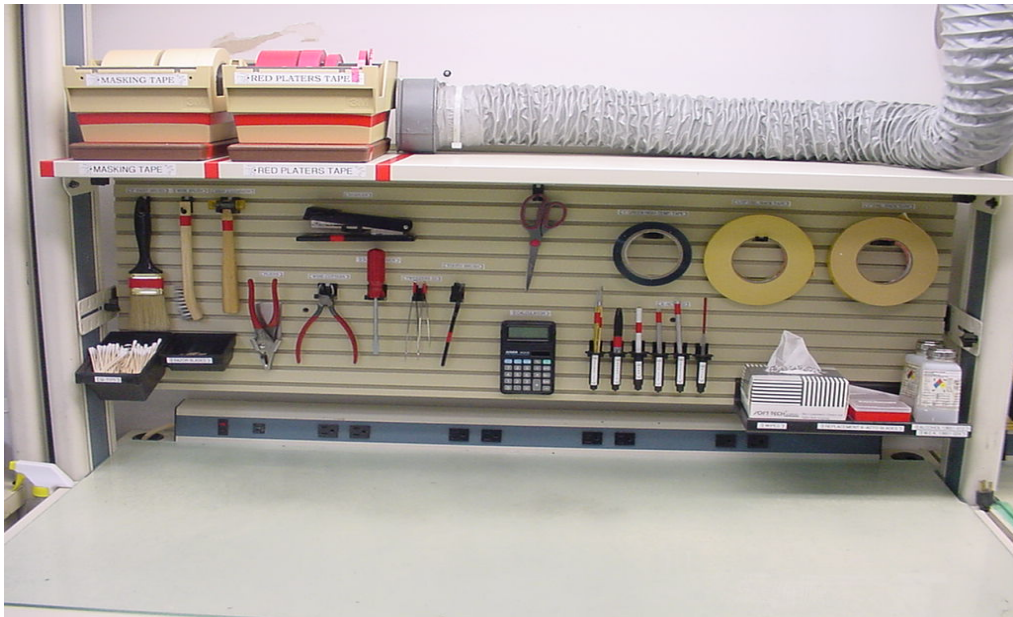
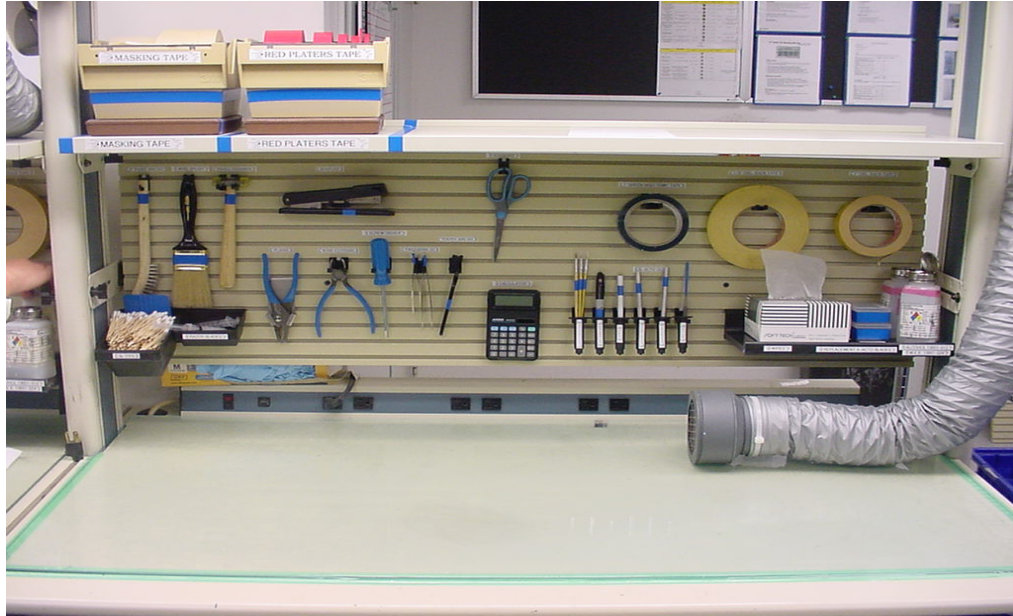
Improved Moral

Improved Productivity

Improved Safety

Improved Transparency

## 5S Examples



## 5S Examples



## Visual Management

**Definition** – making information about production processes and fundamental daily activities visually available in a coherent, timely, and regular manner.

### **Benefits:**

- Clear, simple Visuals for Production Status
- Improved Communication between Departments and Shifts
- Quicker Response to Abnormalities
- Increased awareness of Waste/Scrap
- Culture Change
- Peer Pressure for Improvement

## Visual Management System Implementation Steps

- Identify a territory
- Organize the Workplace (5-S)
- Create Visual Displays
- Identify Measurable and Implement Visual Controls

### **Typical Topics:**

Safety  
Cross Training  
Productivity Measurements  
Production Status  
Process Performance  
Housekeeping  
Defect/Scrap Rates

## Batch Size Reduction

**Definition** – a manufacturing approach that emphasizes the reduction in process batch sizes by eliminating the system constraints requiring large batch sizes – also known as One-Piece-Flow.

### **Discussion:**

Batch size reduction is critical if a truly JIT organization is to be achieved. The first thing to understand is that this is a completely different problem from Setup Reduction. Batch size is driven by constraints within the batch process and has nothing to do with setup or order size. Those constraints are:

- Tradition – “we’ve always done it this way”
- Lack of Instructions – “I don’t know how”
- Equipment limitations – “it only works this way”
- Material Limitations – “it comes in this quantity”
- Co-dependency – “it takes two pieces to make it work”

**How To:**

1. Identify the batch operations and constraining factors.
2. Develop the alternatives and determine their feasibility (note: you must answer the question, how does this improve profitability).
3. Implement the chosen alternative
4. review and re-evaluate after implementation (kaizen)

## **Cellular Manufacturing**

**Definition** – a manufacturing approach in which equipment and workstations are arranged in a bounded area to facilitate small-lot, continuous-flow production.

**Benefits:**

- Better use of human resources
- Easier to automate
- Easier to control
- Multifunctional workers
- Reduced material handling and transit time
- Reduced setup time
- Reduced work-in-process inventory

**Contraindications:**

- Inadequate part families – Process variability and process sequence variability will result in cell layouts with low overall levels of productivity.
- Poorly balanced cells – Bottle neck operations, long cycle operation or unavoidable batch processes prevent Takt time performance.
- Craftsman Skills requirements – Expanded training and the difficulty in scheduling workers hampers Cellular Manufacturing.
- Increased capital investment – Multiple cells with duplicate equipment requirements may result in unaffordable capital requirements.

**Fundamentals:**

- Material Flow – Cells are arranged in relation to each other so that material movement is minimized.
- Capital proximity – Large and/or expensive machines which cannot be easily relocated to cells should be located between the cells that use them (Point-of-Use).
- Assembly line – The layout of machines within each cell should resemble a small assembly line.
- Mobility – Quick positional adjustments should be used to arrange/rearrange the machines within a cell.
- Layout proximity – Sequential processes need to be placed side by side.
- Unified Management Structure – the productive resources need to answer to the same voice.



## **Standardized Work**

**Definition** – the process of documenting and standardizing tasks throughout the value stream (Process Instructions and Standard operating Procedures)

### **Benefit:**

- Increase in the Effectiveness of Cross-training
- Increased sustainability of product and procedural improvements.
- Less downtime due to absenteeism
- More Consistent production Schedules
- Reduced training costs

### **Process Instruction Content:**

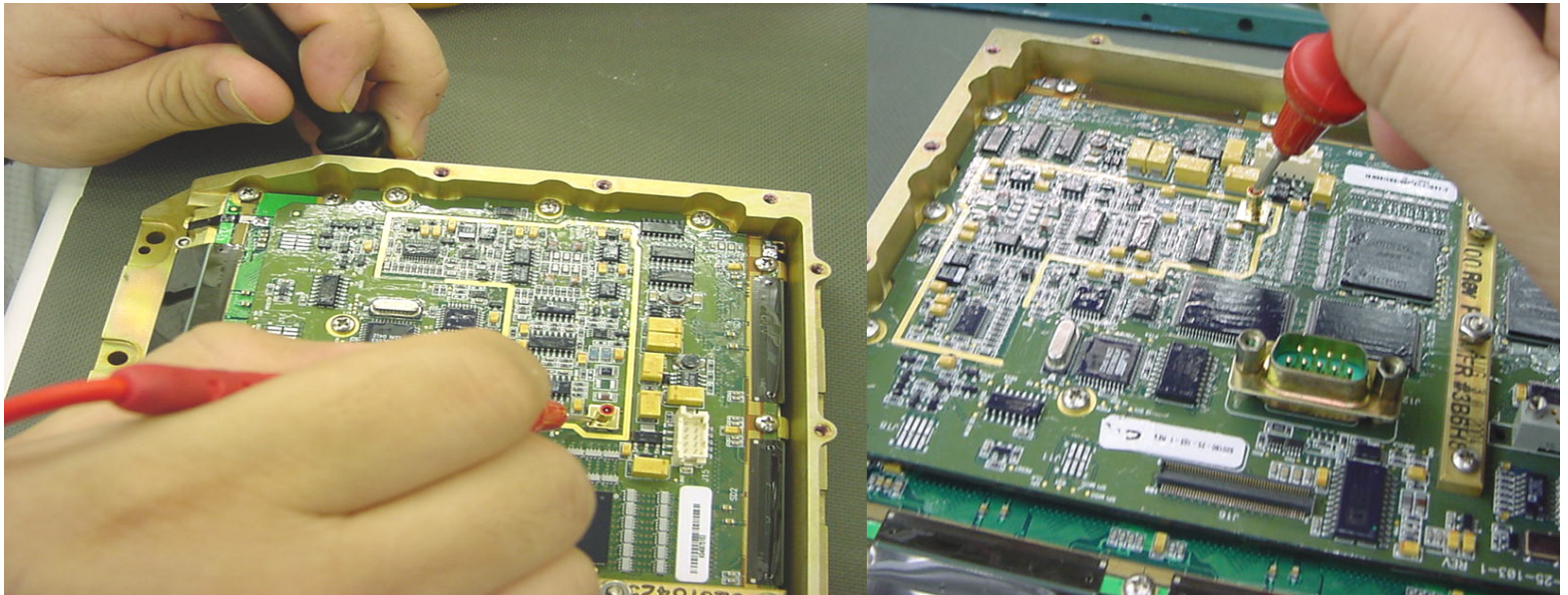
1. Part number and description
2. Drawing revision
3. Next use list
4. Process Instruction revision
5. Process bill of material
6. Tool/Fixture list
7. Miscellaneous specifications (Equipment settings, time requirements, etc.)
8. Task Instructions: The instructions should be complete and adequate to enable a qualified equipment operator to perform the process. The liberal use of visual aids is highly desirable.

## Example Of Preferred Detailed Work or Inspection Instructions

### GDLS 920 Ohm Test

Touch the black lead of a Digital Multi Meter to any portion of the chassis metal. While keeping the black lead in place, touch the red meter lead to the coax. Connector (J3), both on the shield and in the center. See below. Observe reading on Multi Meter for each point tested. A steady reading of less than 1 meg ohm is considered a fault. A quick reading of less than 1 meg that changes within a few seconds to over 1 meg ohm is NOT considered a fault.

Figure 1



**NOTE:** There are capacitors in the circuit. The meter will attempt to charge them. The meter will read a lower ohm value at first, then change to a higher reading. During the time spent conducting the test, the meter may charge the capacitors to a reading past the upper limit of the meter (40 meg) and display “O.L”. This is normal.

## **PFMEA Overview**

### **What is it?**

A structured approach to:

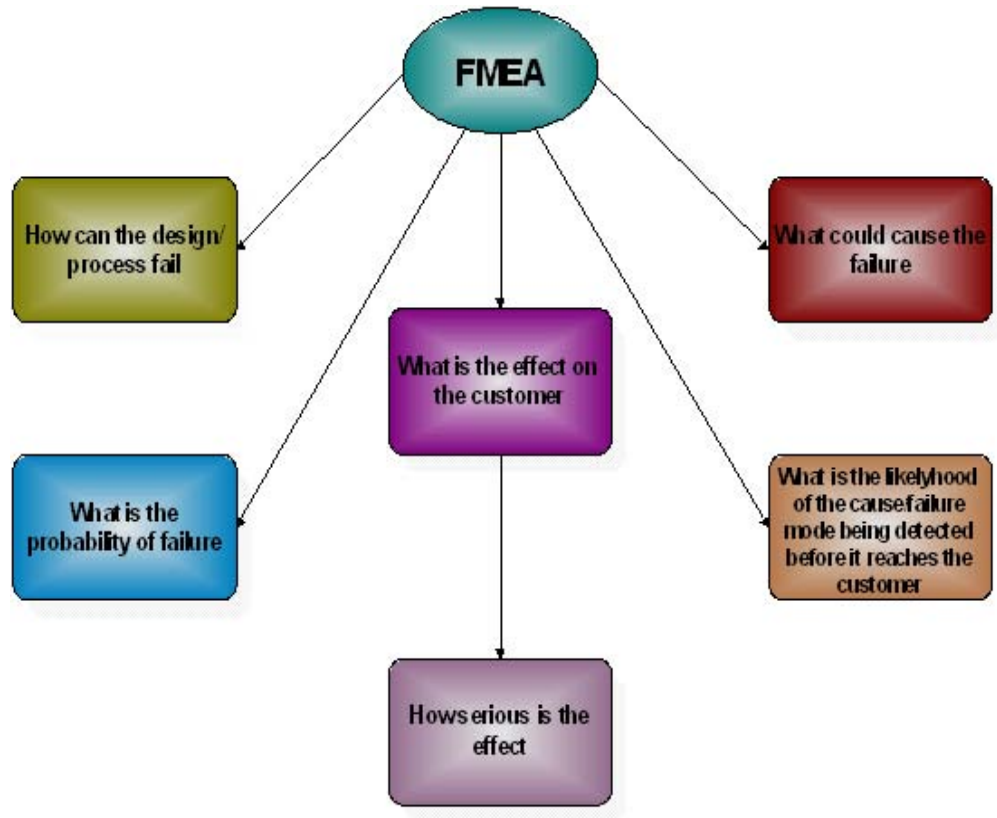
- Identifying ways the product or process can fail
- Estimate the risk associated with specific causes
- Identify & prioritize actions which would eliminate or reduce the chance of the potential failure to occur
- A key tool for the process team to improve the process in a preemptive manner (before failures occur)

**FMEA** - reduces the risk of failures by:

- Aiding in the objective evaluation of design requirements and design alternatives
- Aiding in the initial design for manufacturing and assembly requirements. Identifies the process variables to focus controls
- Increasing the probability that potential failure modes, ranked according to their effects on the customer critical requirements have been considered in the development process
- Aiding in the planning of thorough & efficient validation plans
- Provide future reference to aid in analyzing field concerns & evaluating design and process changes

### **Purpose & Benefit**

- Improves Quality, reliability and safety of products
- Increased customer satisfaction
- Reduces product development timing and cost
- Documents and tracks actions taken to reduce risk

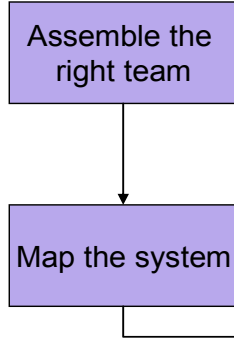


## FMEA Overview

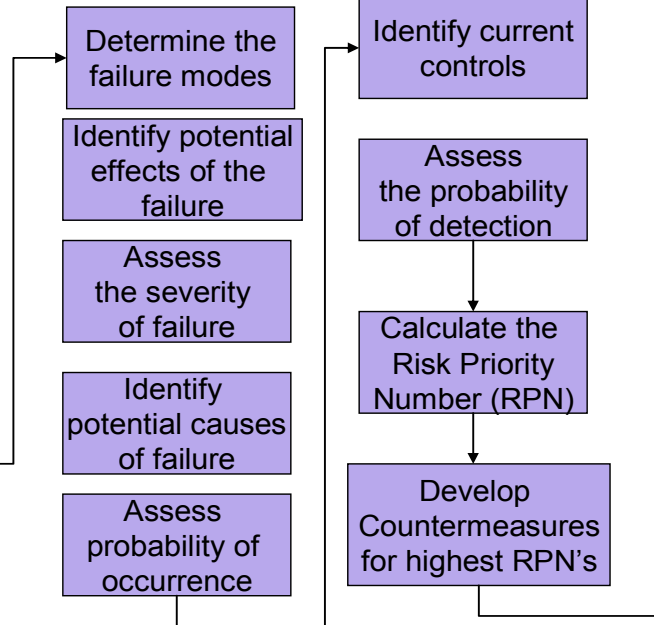
Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	OCC	Current Controls	DET	RPN	Actions Recommended
		What is the Effect on the Outputs?	How Bad?	What are the Causes?	How Often?	How can this be found?	How well?		What can be done?
	What can go wrong with the Process step?								
What is the Process Step									

# FMEA Roadmap

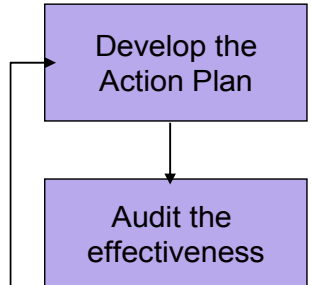
## PREPARATION



## CONDUCTING THE MEETING



## FOLLOWUP



# Process FMEA Form

### PROCESS Failure Modes and Effects Analysis (FMEA)

Process or product name:		FMEA Team:	
Responsible:		Prepared by:	Page _____ of _____
		FMEA Date (orig) _____ (Rev) _____	

Process step	Key Process Input	Potential Failure Mode	Potential Failure Effects	SEV	Potential causes	OCC	Current Controls	DET	RPN	Actions Recommended	Responsibility	Actions Taken	SEV	OCC	DET	RPN
What is the process step	What is the key process input variable (KPIV's)	In what ways does the input go wrong/vary?	What is the impact on the key output variables (customer requirements) or internal requirements?	How severe is the effect to the customer	What causes the key inputs to go wrong	How often does cause of FM occur	What are the existing controls, procedures (inspection and test) that prevent either the cause or the failure mode?	How well can you detect cause of FM	SEV/OCC/DET	What are the actions for reducing the occurrence of the cause, or improving detection? (should have actions only on high RPN's or easy fixes)	Who is responsible for the recommended actions	What are the completed actions taken with the recalculated RPN? Include completion month/year	SEV	OCC	DET	RPN

## **Process Mapping**

### **What is the tool?**

- Graphical illustration of the ACTUAL process (Not the should be)

### **What will the tool identify?**

- All value added and non value add process steps
- Process inputs
- Process or product outputs
- Data collection points

### **When do you apply process mapping?**

- Always

### **What will a process map provide for you?**

- An agreed upon foundation for team activity
- Identification of outputs needing measurement studies
- Identification of outputs for capability studies
- Opportunities for elimination of non value add steps

### **Preparing the Process Map**

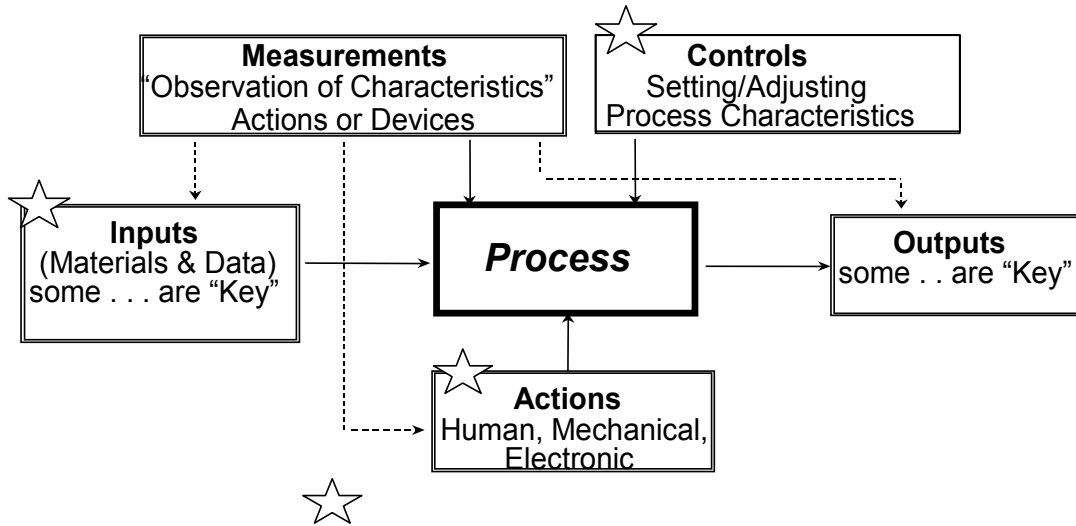
Team Effort – one person does not have all of the process knowledge:

- Manufacturing Engineers
- Line Operators
- Line Supervisors
- Maintenance Technicians

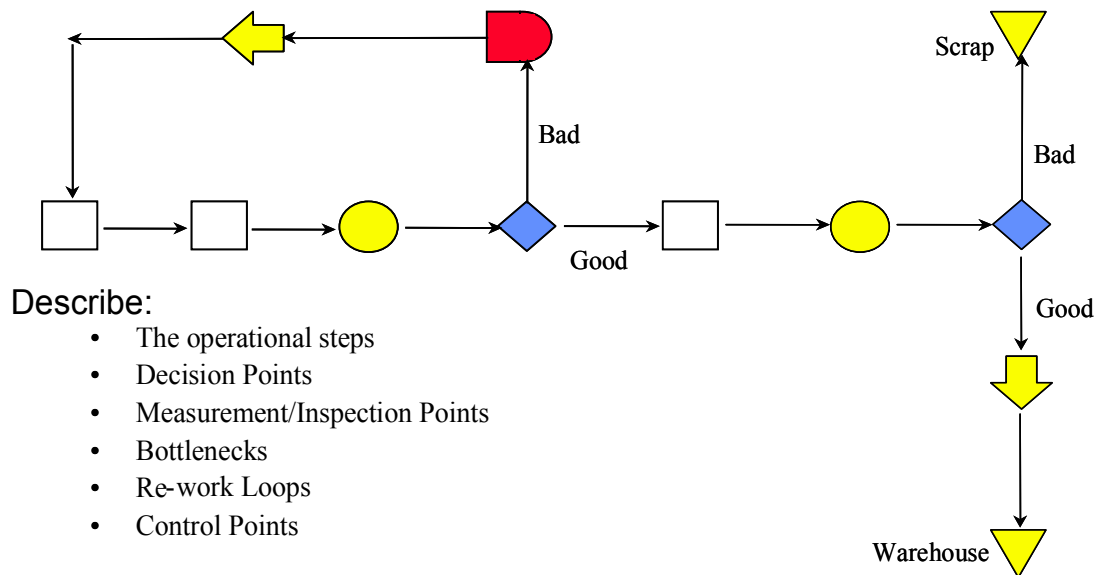
#### Inputs to Mapping

- Brainstorming
- Operator Manuals
- Engineering Specifications
- Operator Experience
- 5M's and a P
- Machine (Equipment), Method (procedures), Measurement, Materials, Mother Nature (Environment), People

# "In's" & "Out's" of a Process



## Process Map- Basic Structure



## Statistical Process Control

Suppliers are encouraged to utilize statistical methods to control processes, improve quality and reduce costs. The application of statistical methods to the manufacturing process and/or product characteristics can be based on:

- Major/minor Characteristics identified in the Technical Data Package
- Repetitive failures associated with the manufacturing process and are responsible for high defect quantities and/or cost
- Dominant process characteristics

When control charts are used as the basis for product acceptance, charts should clearly indicate:

- Identification of product/process flow to the control plan
- The sample measurements used to calculate data points and the date taken
- Corrective action taken for out of control conditions and/or out of specification conditions

A supplier desiring certification of their SPC Program must present a written procedure, control Plans and Sample data collection and Capability analysis to the assigned SQA Regional Lead. The Regional Lead will review the submittal, co-ordinate with the supplier and ultimately issue a certification letter for the supplier's files.

## Fish Bone Diagram

The cause and effect diagram is used to explore all the potential or real causes (or inputs) that result in a single effect (or output). Causes are arranged according to their level of importance or detail, resulting in a depiction of relationships and hierarchy of events. This can help you search for root causes, identify areas where there may be problems, and compare the relative importance of different causes.

Causes in a cause & effect diagram are frequently arranged into four major categories. While these categories can be anything, you will often see:

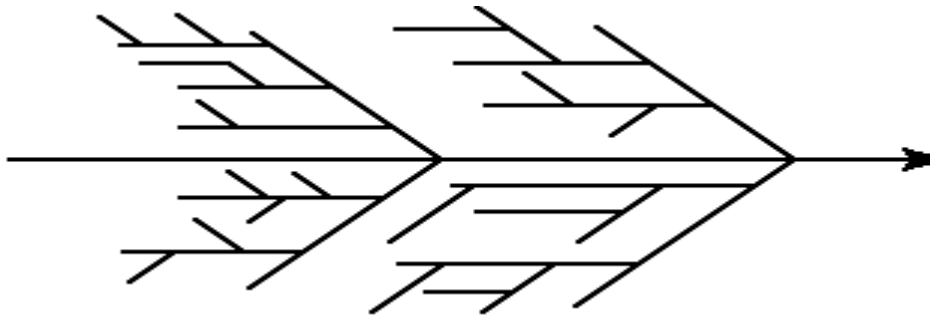
- Manpower, methods, materials, and machinery (recommended for manufacturing)
- Equipment, policies, procedures, and people (recommended for administration and service).

Cause & Effect Diagrams are visual tools to identify, explore and graphically display, in increasing detail, ***all the possible causes related to a problem or condition to discover its root causes.***

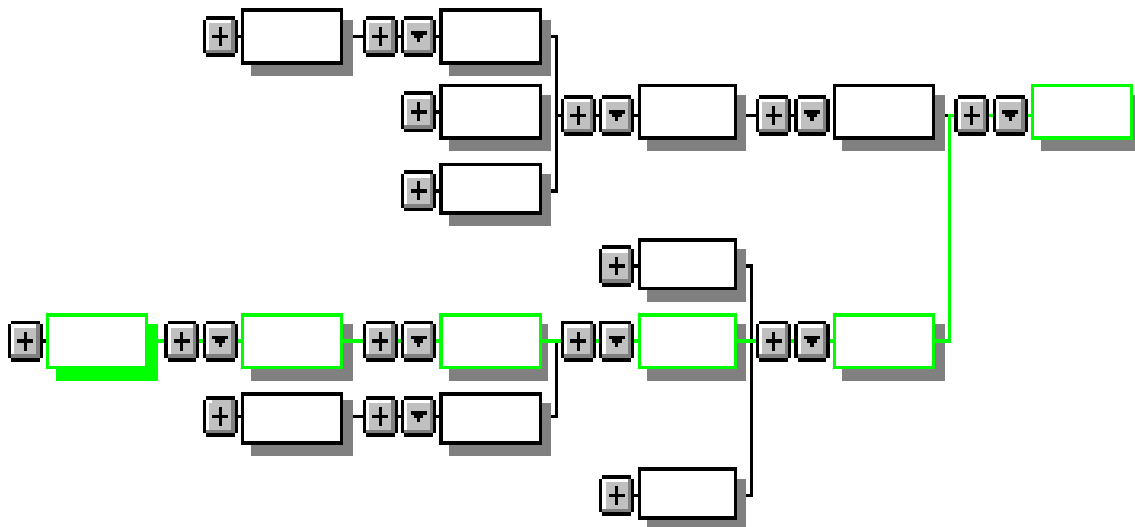
- *Focuses team on the content of the problem*
- *Creates a snapshot of the collective knowledge of team*
- *Creates consensus of the causes of a problem*
- *Builds support for resulting solutions*
- *Focuses the team on causes not symptoms*



The C&E diagram is also known as the fishbone diagram because it was drawn to resemble the skeleton of a fish, with the main causal categories drawn as "bones" attached to the spine of the fish, as shown below.

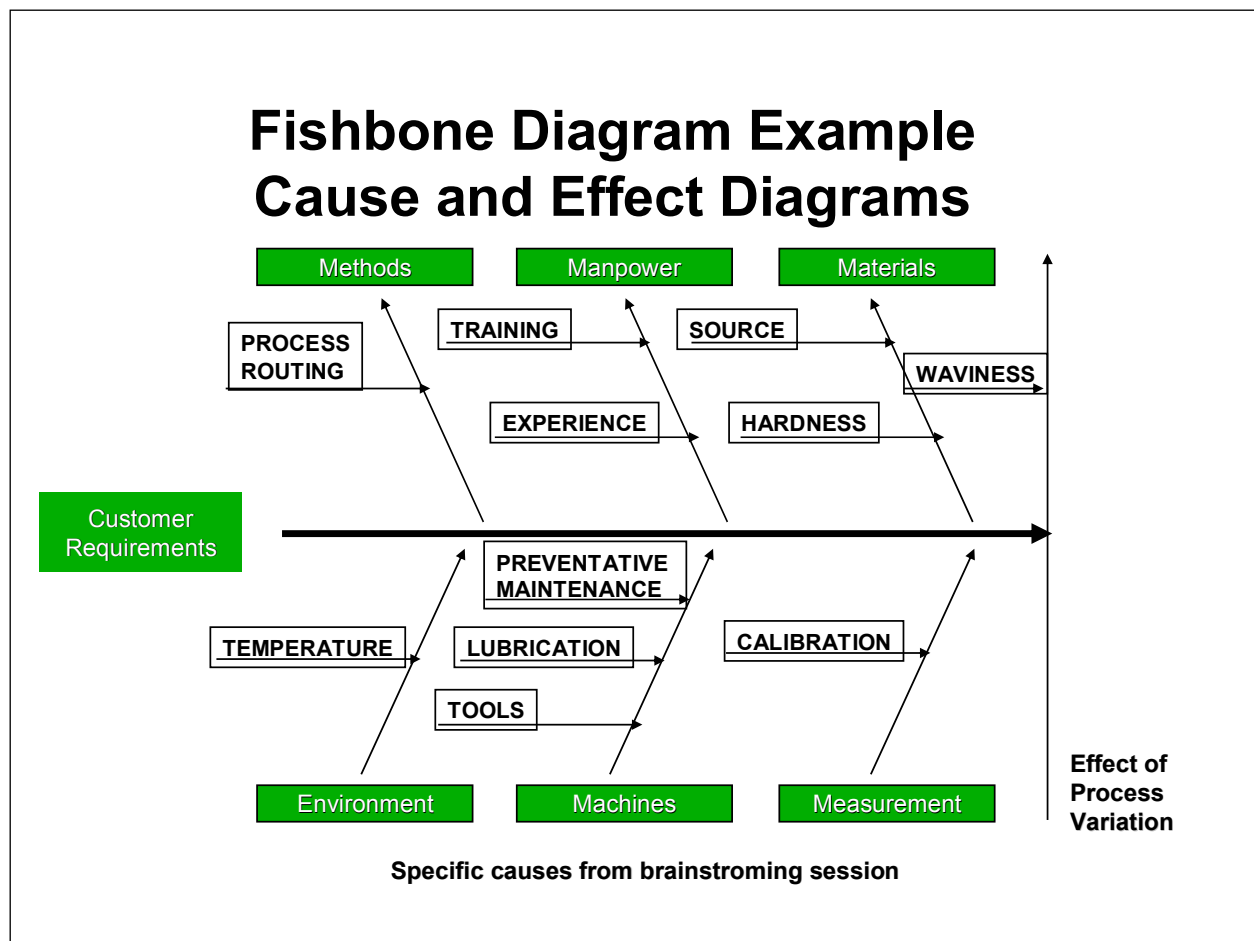


Cause & effect diagrams can also be drawn as tree diagrams, resembling a tree turned on its side. From a single outcome or trunk, branches extend that represent major categories of inputs or causes that create that single outcome. These large branches then lead to smaller and smaller branches of causes all the way down to twigs at the ends. The tree structure has an advantage over the fishbone-style diagram. As a fishbone diagram becomes more and more complex, it becomes difficult to find and compare items that are the same distance from the effect because they are dispersed over the diagram. With the tree structure, all items on the same causal level are aligned vertically.



## To successfully build a cause and effect diagram:

1. Be sure everyone agrees on the effect or problem statement before beginning.
2. Be succinct.
3. For each node, think what could be its causes. Add them to the tree.
4. Pursue each line of causality back to its root cause.
5. Consider grafting relatively empty branches onto others.
6. Consider splitting up overcrowded branches.
7. Consider which root causes are most likely to merit further investigation.



## Measurement System Analysis

- Measurement system is the index of the process
- Minimizing variability of the measurement system is critical for understanding true process capability
- An evaluation of the measurement system MUST be undertaken to ensure effective analysis of an subsequent data generated for a given process/product characteristic
- Measurement error is a statistical term meaning the net effect of all sources of measurement variability that cause an observed value to deviate from the master.

**Observed Value = Master Value + Measurement Error**

**Measurement Variability << Product Variability**

### Gage R&R

- Limited \* estimate of overall variation in the measurement system Measure of natural variation of repeated measurements involving multiple operators.
  - Includes both Repeatability and Reproducibility
- \* "limited" in the sense that there may be other important Sources of Variation beyond our focus on Operator-to-operator and gage Repeatability

$$\sigma_{\text{R \& R Measurement System}}^2 = \sigma_{\text{Repeatability}}^2 + \sigma_{\text{Reproducibility}}^2$$

2 Component Parts

# Repeatability

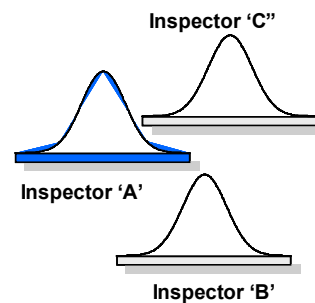
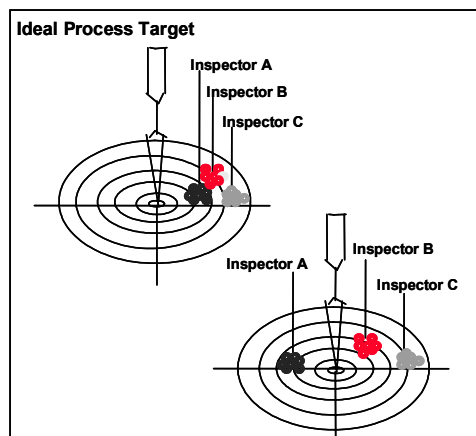
**Repeatability** (A Component of Precision)

$\sigma$  Re peat

- **The inherent variability of the measurement system**
- **Variation that occurs when repeated measurements are made of the same item under absolutely identical conditions**
  - Same operator
  - Same set-up
  - Same units
  - Same environmental conditions
  - Short-term
- **Estimated by the pooled standard deviation of the distribution of repeated measurements**
- **Repeatability is always less than the overall variation of the measurement system**

# Reproducibility

**The difference in the average of the measurements made by different persons using the same or different instrument when measuring the identical characteristic.**



## **5 WHY**

### **5 Step Improvement Model (TLH Enhanced)**

**These are the tools we currently have and future tools we will include in the model as the teams progress.**

#### **Step 1 Define The Problem**

- Current Tools: Problem Statement Development Checklist, Check sheets for Data Collection
- Future Tools: Measurement System Analysis (Six Sigma), Process Capability Analysis (Six Sigma), Cost of Poor Quality Calculations (Six Sigma)

#### **Step 2 Identify/Analyze Causes**

- Current Tools: Brainstorming (WSA, Lean, Six Sigma), Fishbone Diagram (Lean, Six Sigma), Process Mapping (WSA, Lean, Six Sigma) Including “7 Deadly Wastes” Analysis (Lean), (WSA), 5 Why’s (Lean, Six Sigma) & How to Check Your Work, Root Cause Verification (Six Sigma)
- Future Tools: Pareto Charts (Six Sigma), Histograms, Pareto Analysis, FMEA’s (Six Sigma), Design of Experiments (Six Sigma)

#### **Step 3 Identify/Analyze Solutions**

- Current Tools: Brainstorming (WSA, Lean, Six Sigma), Multi voting (Six Sigma), Pros/ Cons Analysis (WSA), Effect/ Feasibility Analysis ,Cost/ Benefit Analysis (WSA, Lean, Six Sigma), Force Field Analysis (Six Sigma), Decision Matrix Future Tools: Kanban (Lean), 5S (Lean), Poka-Yoke (Lean),

#### **Step 4 Develop Action Plan**

- Current Tools: O-M-R Planning Tool (WSA)
- Future Tools: Reverse Planning, Gant Charts (Microsoft Project)

#### **Step 5 Evaluate**

- Current Tools: Before and After Comparison, Standardization, Lessons Learned
- Future Tools: Intervention Lines

## 5 Why Format:

**Describe the problem:**

**1. Why? (why did the above problem occur?):**

**2. Why? (determine what caused "why" number 1):**

**3. Why? (determine what caused "why" number 2):**

**4. Why? (determine what caused "why" number 3):**

**5. Why? (determine what caused "why" number 4):**

**Continue this process until you get to the REAL root cause of your problem (why you can no longer answer the question "why").**

## 5 Why Non-Example:

Determine	is	is not
<b>What - (<i>what is the problem specifically, what the problem is not?</i>)</b>	Yellow perch number is declining.	Any other fish in Lake Michigan Any other fish in the Great lakes
<b>Who - (<i>who is affected or affects the problem, who it is not?</i>)</b>	Commercial fishermen Amateur anglers	Boaters Picnickers
<b>Where - (<i>where did the problem occur/where does the problem reside, where it did not occur?</i>)</b>	Lake Michigan	Other Great Lakes & St. Lawrence Seaway Inland lakes in any of the states Rivers in these states
<b>When - (<i>When did the problem occur - be as specific as possible, when did it not occur?</i>)</b>	Since 1990	Not in 80's or previous times before
<b>How Many - (<i>how many in specific data, how many not effected?</i>)</b>	80% decline in past 10 years	100%
<b>How Much/How Often - (<i>how much/often effect in the field, at the customer, etc., how much/often not effected?</i>)</b>	10 Consecutive year dismal yellow perch reproduction	Not more than 10 years

## **Kanban**

**Definition - Kanban** is Japanese for “card” – Pull Scheduling combined with traveling instructions conveyed by simple visual devices in the form of cards, balls, carts, containers, etc. and can be applied to both material flow in the factory, information or project flow in the office, and material flow between suppliers and customers.

### **Benefits:**

- Reduced Inventories
- Predictable flow of Materials
- Simplified Scheduling
- Visual Pull System at the Point of Production
- Improved Productivity

### **Prerequisites:**

- Repetitive production in small lots
- Balanced manufacturing system (capacity balancing model)

### **Basic Kanban Rules**

1. Move a Kanban only when the lot it represents is consumed.
2. No withdrawal of parts without a Kanban is allowed.
3. The number of parts issued to the subsequent process must be the exact number specified by the Kanban.
4. A Kanban should always be attached to the physical parts.
5. The preceding process should always produce parts in the quantities withdrawn by the subsequent process.
6. Defective parts should never be conveyed to the subsequent process.
7. Process the Kanbans at every work center in the order in which they arrive at the work center.



## Kaizen

**Definition** – a philosophy of continual improvement, emphasizing employee participation, in which every process is continuously evaluated and improved in terms of time, resources, quality, and other aspects relevant to the process.

### **Two types of Kaizen:**

Flow kaizen – value stream improvement

Point Kaizen – elimination of waste

### **Discussion:**

Kaizen is often confused with Kaizen Events. They are not the same. Kaizen events are artificial group setups to address single subjects/areas. They are usually one time only affairs. Kaizen is intended to be incorporated as a normal day by day approach to the improvement of the entire value stream.

### **How To:** Hold a Kaizen Event

#### **1. Select a subject for the event.**

Select a bounded, ongoing activity to be the subject of the event. You should concentrate on those activities which are associated with significant revenue flows and where you already suspect there could be significant savings available.

#### **2. Select and assemble the team.**

The team must have a cross section of talents and experiences. Every member selected should be selected because of what they bring to the group not because they are available surplus at the time of selection. It is critical that a healthy number of experienced on-the-floor operators be included. Likewise, some of the local supervision and procedural personnel should be included.

#### **3. Affirm management's commitment.**

It is essential that Upper Management adopt a visible profile throughout the process. Upper Management should attend the kickoff meeting. Management should express their support for change and their acceptance that some money may have to be spent. The normal command structure should be suspended with reference to the team's activities.

#### **4. Present a road map.**

An outline of the normal approach along with a time frame should be given to the team.

#### **5. Train the Team.**

Train the team in the 7 Wastes and the 14 Techniques involved in Lean Manufacturing. A generous number of examples should be given. A discussion should be held about parallel approaches to the area under consideration. The team should be given some time to go away and formulate their Ideas.

**6. Perform a “present state” analysis.**

A review of the current state of affairs in the area in question should be held. Layouts (complete with distances), process charts (complete with setup and process times) should be evaluated.

**7. The “next step” proposal should be generated.**

The team should discuss its different ideas and proposals. A proposal list should be written up and those items on which additional data are required noted. The additional information should be gathered and the full list should be given a final thumbs up review. An action plan consisting of the best ideas should be written up.

**8. The team presents its action plan to management.**

At this point, the team should present their ideas, reasoning, and action plan to management. Management may reject individual items, but should do so only for logical reasons which are communicated directly to the team. The concept of low hanging fruit should be emphasized.

**9. Assign the Action Items.**

The team members themselves should implement the no-brainer and quick-turn changes. Management will assign those items requiring longer term planning, capitol equipment or technical expertise.

**10. Track activities and results using Visual Management.**

Set up a special bill board on which the Kaizen projects are detailed, the action items are Gantt charted. The before and after performance should be graphically displayed.

**11. Implement the changes.**

In most cases, the identified opportunities will follow Pareto’s 80-20 Rule (“80% of consequences stem from 20% of the causes”, Joseph Juran). Items should be acted upon immediately. No management drag-outs, no prolonged review/approval requirements

**12. Measure the improvement and report results.**

The team should make a final presentation to management as soon as those short term items assigned to the team members are completed. The status on all of the action items should be reviewed. Gains and performance improvements should be graphically displayed.

## **10 MOST COMMON ERRORS**

- 1) **Processing Omissions**
- 2) **Processing Errors**
- 3) **Error in setting up the work piece**
- 4) **Assembly Omissions (Missing Parts)**
- 5) **Inclusion of improper part / item**
- 6) **Wrong work piece**
- 7) **Operations errors**
- 8) **Adjustment, measurement, dimensional errors**
- 9) **Errors in equipment maintenance or repair**
- 10) **Error in preparation of blades, jigs, or tools**



## **Quality Kaizen Tools**

- **Process Mapping**
- **Cause & Effect Diagram**
- **Gage R&R**
- **Process Capability Studies**
- **Graphical Analysis Methods**
  - **Pareto Analysis**
  - **Histogram**
  - **Scatter Diagram**
  - **Correlation Analysis**
  - **Check Sheet**



## **Quality Kaizen Tools**

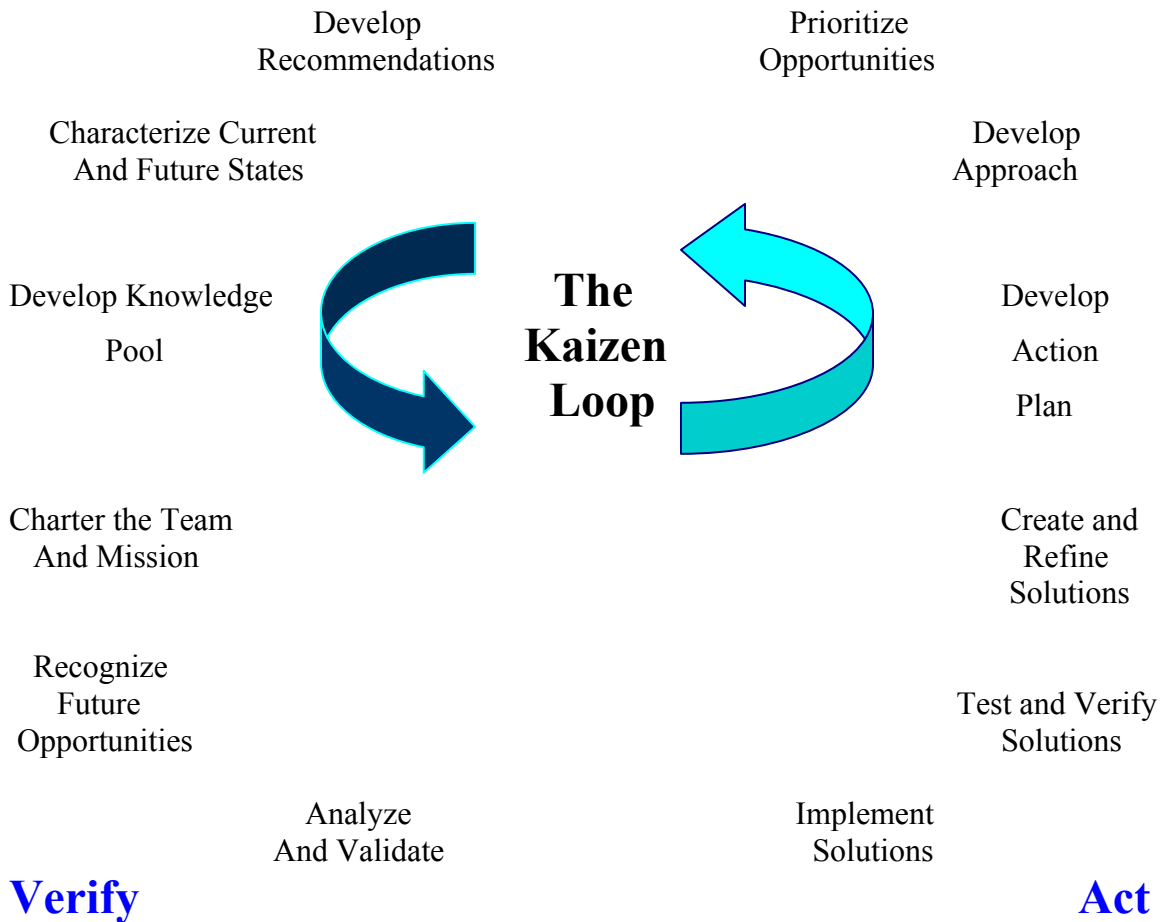
- *Statistical Methods*
  - *Correlation and Regression*
  - *Design of Experiments (DOE)*
- *Rolled Throughput Yield*
- *FMEA*
- *Error Proofing*
- *Control Plans*

## ***Typical Kaizen Event Improvement Results***

- ↪ ***30% Increase in Productivity***
- ↪ ***50% Reduction in WIP Inventory***
- ↪ ***50% Reduction in Defects***
- ↪ ***50% Reduction in Scrap & Rework***
- ↪ ***30% Reduction in Floor Space***
- ↪ ***3 Safety or Ergonomic Improvements***
- ↪ ***>\$40k Cost Savings (Annual + One-time)***

## Analyze

## Plan



### Implementation

Finally and most important of all, it must be made clear that everyone will be participating. This is an effort to determine what type of business your firm will be. In the end there will only be two types of businesses, the quick and the dead. The team decides which.

## **Process Flow Charting**

A flowchart is a graphical representation of a process, depicting inputs, outputs and units of activity. It represents the entire process at a high or detailed (depending on your use) level of observation, allowing analysis and optimization of workflow.

A flowchart is a graphical representation of a process. It represents the entire process from start to finish, showing inputs, pathways and circuits, action or decision points, and ultimately, completion. It can serve as an instruction manual or a tool for facilitating detailed analysis and optimization of workflow and service delivery.

- Information on each step of the process at a minimum:
- Process number of the process step.
- Description of process step (Receiving Inspection, Cut Tube, Bend Tube, Assemble Part A to Part B, etc.)
- Process action: stored, move, inspect or process.
- Reference work instruction or inspection instruction document number.
- What characteristic is being inspected (Diameter 10.5mm +/- .5mm). Identify Key Product Characteristics, QARs/QAPs if applicable
- Type inspection (Visual, Gage #, Caliper, Tester # etc.).
- Inspection frequency and sample size.
- If any process is outsourced, the name of the outsourced supplier.

## **Process Flow and Data Worksheet**

### **Purpose:**

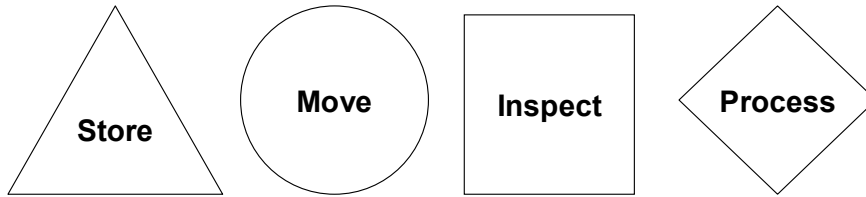
- To map the process (from receiving through final pack)  
For better understanding & organization.
- To show inspection details at a glance.
- To aid the supplier in understanding their process before parts are manufactured.
- To have the ability to document process changes.
- A process audit document
- To use as a tool at FPI

### **Specifics:**

- Gives the supplier a simple value added document to detail their process.
- May be requested for current product by your Regional SQA if there is a “major” or “intensive management situation”.

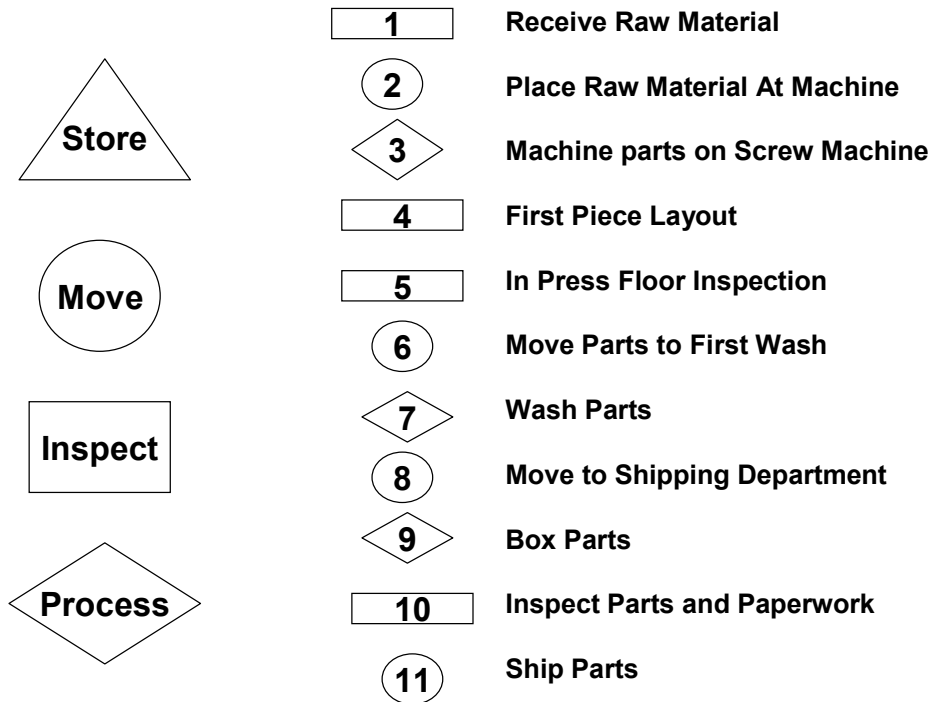
# Understand Your Process

## Process Flow Charts



## Symbols to represent process flow

### Process Flow Charts



# Process Flow

## Why Utilize Process Flow Charts?

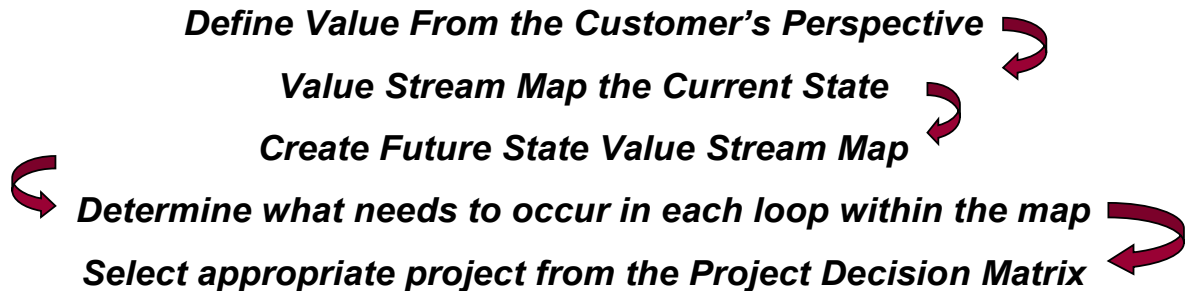
- Save Money - \$ in lost productivity.
- Reduce Issues at start ups.
- To help GDLS understand the Supplier's Process At A Glance.
- It will let us know, Does the Supplier Understand the Process ?
- Show whether the Supplier has captured All the Requirements.
- Identify where Out Sourcing is taking place.
- Move from Part Control to Process Control.
- Move from Detection (parts produced) to Prevention.
- Help reduce Critical Shortages.
- Freezes the Document /Process at FPI making it easier to identify later changes to the process Changes Documented (Material, Outsourcing, Process, etc. ...) No Change Clause
- Identifies where Process Controls, QARs/QAPs/KPC, & Error Proofing should be implemented.
- Used for a Tool for FPI



## Continuous Improvement

- Process Characterization
  - Targeting and benchmarking of key process, product, and service characteristics resulting in selecting common success factors which lead to value creation.
- Process Optimization
  - Targeted at the measurement and improvement of process variables which, due to significant variation, have a detrimental effect on key process characteristics.

### Continuous Improvement: Managing the Implementation Tools



#### Classic Kaizen

**Improving Productivity Through:**

- **Waste Elimination**
- **One Piece Flow**
- **Pull Systems**
- **Business Process Kaizen**
- **Global Production System**

#### Quality Kaizen

**Improving Quality Through:**

- Define: Quality Failure Costs**
- Measure: Process Capability**
- Analyze: Quality Tools**
- Improve: Process Changes**
- Control: Process Control**

## 7 Step Check Sheet:

**Definition:** This document is a "memory jogger" to take you through the steps of the GDLS 8-step process. The items with an "asterisk" are required, at a minimum, when performing this process. The other items are strongly recommended and will guide you through a solid problem solving process. This 8-step process is required for any major issues and intensive management situations. It is strongly recommended for all NC's as root cause determination is the only way to fully eliminate the problem.

<b>Required</b>	<b>1. Use The Team Approach</b>	<b>Responsible Party</b>	<b>Completion Date</b>
*	Champion named - someone at a level high enough to support team corrective action with resources and take care of road blocks.	-	-
*	Team Leader	-	-
	Suppliers on the Team - as required	-	-
	Customer on the Team - as required	-	-
*	Other pertinent personnel on the Team - operator, QE, ME, PE, Floor Supervisor, etc.	-	-

	<b>2. Describe The Problem</b>	<b>Responsible Party</b>	<b>Completion Date</b>
*	Identify in quantifiable terms - who, what, when, where, why, how, and how many.	-	-
	State problem in "customer" terms..	-	-
*	Start/End dates listed	-	-
*	Percent/number defective listed	-	-
*	Frequency of problem listed	-	-
	Actual measurements reported	-	-
*	Specifications listed	-	-

	<b>3. Contain The Symptoms</b>	<b>Responsible Party</b>	<b>Completion Date</b>
*	Determine appropriate interim action - inspect, sort, scrap, rework, certify, - list short term containment actions.	-	-
*	All stock locations purged/put on hold - (___)product on floor, ___ finished goods (warehouse), ___ in-process & on line, ___ customer's site, ___ product in transit, ___ product in hold/test/engineering areas etc., ___ other.	-	-
	Percent effectiveness of containment listed	-	-
*	Dates of containment actions listed	-	-
	Sort results listed ___ # sorted, ___ # found, ___ % defective	-	-

	<b>4. Define &amp; Verify Root Cause</b>	<b>Responsible Party</b>	<b>Completion Date</b>
*	5 Why's - ask the question "why" at least 5 times for every potential failure mode (symptom) determined, to get to root cause.	-	-
	Is/Is-Not analysis to determine process who, what, when, where, how many, how much/often.	-	-
	Cause and effect diagram - determines root cause through brainstorming the following items: methods, manpower, materials, machines, measurement, and environment.	-	-
*	Where in the process did the non-conformity occur - what was the current process control, what process control needs to be corrected/error proofed.	-	-
*	Determine/recognize the PROCESS Root Cause	-	-
*	Determine/recognize the SYSTEM Root Cause	-	-
*	Verify the root cause	-	-
*	Determine where and why the non-conformance "escaped" from your plant and error proof (were all the inspections, data gathering, process steps, dock audits, performed properly) .	-	-

	<b>5. Implement &amp; Verify Interim Corrective Action</b>	<b>Responsible Party</b>	<b>Completion Date</b>
*	Implement interim corrective actions taken for the PROCESS.	-	-
*	Implement interim corrective actions for the SYSTEM.	-	-
*	Control, error proof, monitor, verify	-	-
*	Determine verification methods (SPC charts, pareto diagram, paynter chart, testing, etc.)	-	-

	<b>6. Implement &amp; Verify Permanent Corrective Action</b>	<b>Responsible Party</b>	<b>Completion Date</b>
*	Implement Permanent Corrective Actions for PROCESS and SYSTEM		
*	Verify the permanent corrective action with DATA.	-	-
*	Verify any error proofing via increased inspection/data gathering.	-	-
*	Verify permanent corrective actions do not adversely effect process operations upstream or downstream (additional testing, send sample parts to customer for tryout/functional build, etc.)	-	-
*	List data results proving permanent corrective action verification.	-	-

	<b>7. Prevent Recurrence</b>	<b>Responsible Party</b>	<b>Completion Date</b>
*	Update process instructions	-	-
*	Update inspection instructions	-	-
	Modify/update management systems	-	-
*	Implement additional training (floor/station operators, supervisors, engineers, etc.)	-	-
	Review any similar processes/products and implement corrective actions if they apply	-	-
	Audit process to be sure corrective actions remain effective	-	-
	Document lessons learned and communicate	-	-

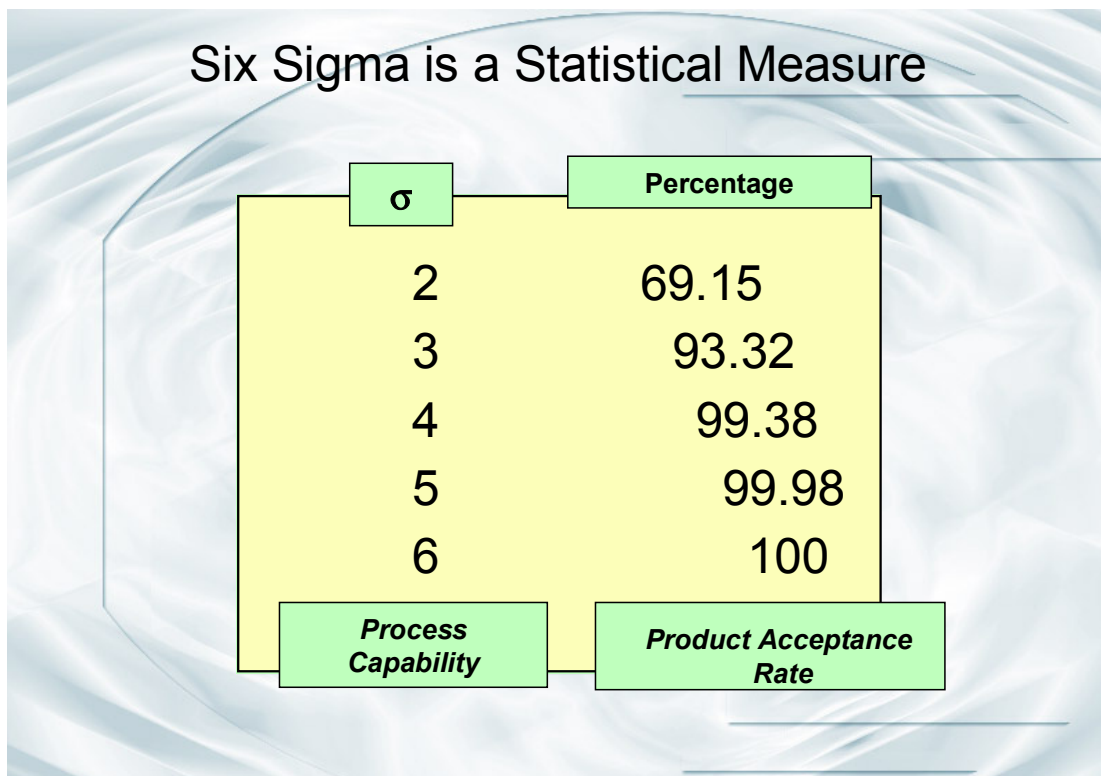
## 7D Corrective Action Form:

Supplier Name:	Supplier VCN:
Location:	Date of Occurrence:
Part # & Description:	Revision Date:
PO #	NC#:
GDLS Plant Affected:	Date Last Updated:
Program Affected:	Date Closed:
<b>1. Use the Team Approach:</b>	
Team Champion:	Issue Date:
Team Leader:	Status: Open _____ Closed _____
Team Members: _____ Title: _____	Phone: _____ Email: _____
<b>2. Describe The Problem:</b>	
<b>3. Contain Suspect Product</b>	
<b>4. Define &amp; Verify Root Cause:</b>	
<b>5. Implement &amp; Verify Interim Corrective Action:</b>	
<b>6. Implement Permanent Corrective Action:</b>	
<b>7. Prevent Recurrence:</b>	
<b>Signoff Notification: Sign electronically (S: your name and date) signifying you have seen this document for review/closure.</b>	
<b>Note: This document is recommended format from any supplier to GDLS that has a "major issue" (assembly plant line stoppage/line down) or an "Intensive Management" situation. A copy of this 7-step format must be supplied to the Regional Lead/SQA for closure. Electronic signatures are needed above to get buy-in from all appropriate parties. For any questions, please contact your Regional Manager of Supplier Quality Assurance.</b>	

# Six Sigma

## What Is Six Sigma?

- Problem solving strategy
- Utilizes disciplined data driven methodology to reduce customer critical defects
- Focus on quality of business than merely product quality
- Identifies projects using performance metric to yield clear financial results
- Developed by Motorola in 80's. Powerful implementation infrastructure and culture developed by GE



## Why Six Sigma?

- To deal with a world of declining product prices
- To compete successfully with the best companies in the world

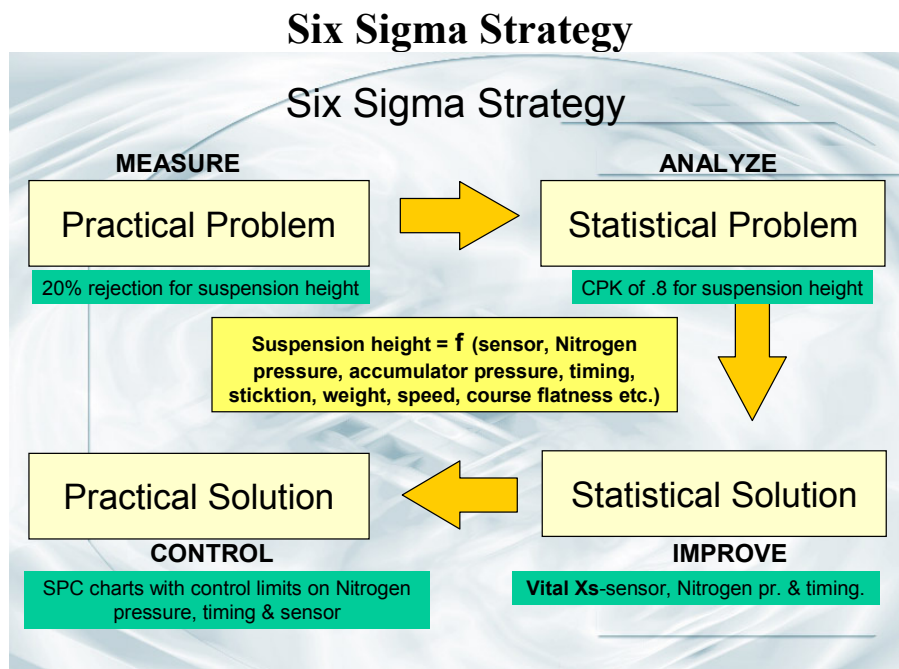
*Need to accelerate our rate of improvement of quality and productivity faster than our competitors*

- To establish standard language and approaches across functions and across businesses.
- To develop the next generation of leaders

## Six Sigma Focus

- High customer satisfaction through flawless execution
- Quantum and not incremental improvements
- Real financial results that impact the bottom line
- Positive and deep cultural change with commitment to continuous improvement in all key business purposes

Passion + Execution = Fast and Lasting Results



## **Service Quality Six Sigma Case Studies**

**Problem Statement:** Delay in disposition of long-term disability application leads to extension of short term benefit resulting in high financial impact on Dupont.

**Project Objective:** Perform the approval process within the cycle time objective of 45-day upper specification limit.

**Project Summary:** Data analysis revealed mean cycle time of 40 days with standard deviation of 10. No significant differences between different sites.

### **Critical process inputs:**

- Incomplete medical and/or job information
- Delay in receiving objective medical information from Employee's physician
- Substantiation of employee's condition by an independent medical evaluation
- Mail time from site to benefit provider agent's desk.

## **Service Quality Six Sigma Case Studies**

**Project Summary:**

### **Process Improvements:**

- Electronic distribution of material to employees and sites and fax server technology eliminating mail times for new applications.
- Improve application package providing more complete directions and forms for employee and personal physician
- Re- negotiate contract with independent medical exam suppliers with tighter standards and financial penalty for poor performance.
- Email confirmation and biweekly status report on each case and introduction of formal quarterly supplier process performance report to Dupont process owner.

**Process mean reduced to 20 days with standard deviation 2 days.  
Annualized savings \$250,000.**

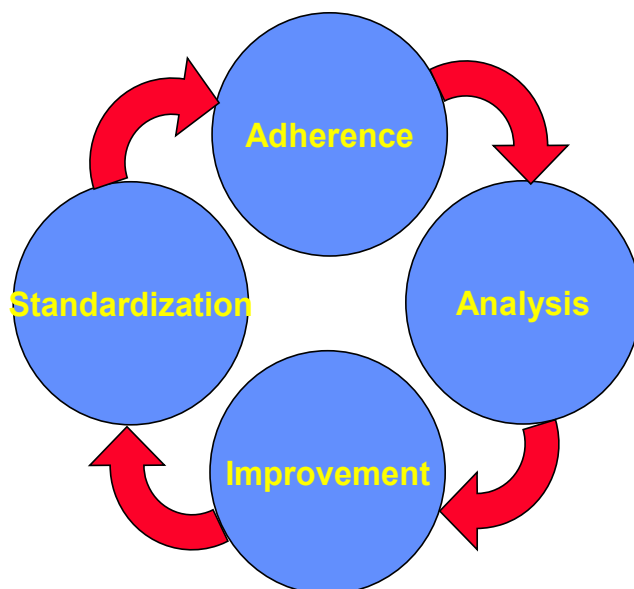


## Mistake Proofing

### **SEVEN STEPS TO MISTAKE PROOFING**

- Step 1:** *Identify and describe the defect*
- Step 2:** *Determine where the defect is discovered*
- Step 3:** *Detail the current standard procedure*
- Step 4:** *Identify deviations from standards*
- Step 5:** *Identify the red flag condition(s) where the defect occurs*
- Step 6:** *Identify the type of mistake proofing device required to prevent the error or defect*
- Step 7:** *Create the device(s) and test for effectiveness*

### **MISTAKE-PROOFING CYCLE**



**Adherence** – to current procedure

**Analysis** – analyze current procedure and performance

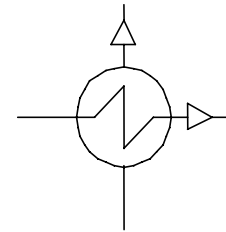
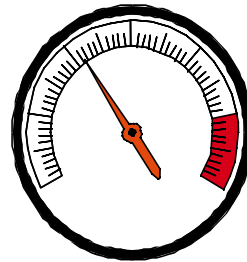
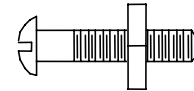
**Improvement** – action based on analysis

**Standardization** – standardize the success

*Note: the similarity to Deming's PDCA Cycle.*

## **COMMON MISTAKE PROOFING DEVICES**

- **Guide/Reference/Interference rod or pin**
- **Template**
- **Limit Switch/microswitch**
- **Automatic counter**
- **Odd-part out method**
- **Sequence restriction**
- **Standardize and solve**
- **Critical condition indicator**
- **Detect delivery chute**
- **Stopper/gate**
- **Sensor**
- **Mistake Proof your device**
  - **Eliminate the condition**
  - **Redesign for symmetry**
  - **Redesign for asymmetry**



## **10 Most Common Errors of Mistake Proofing**

- 1) **Processing Omissions**
- 2) **Processing Errors**
- 3) **Error in setting up the work piece**
- 4) **Assembly Omissions (Missing Parts)**
- 5) **Inclusion of improper part / item**
- 6) **Wrong work piece**
- 7) **Operations errors**
- 8) **Adjustment, measurement, dimensional errors**
- 9) **Errors in equipment maintenance or repair**
- 10) **Error in preparation of blades, jigs, or tools**

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If you have any further questions please contact your Regional SQA Manager or email questions to [sqa@gdls.com](mailto:sqa@gdls.com).