

# The 8-D Methodology

## Team Oriented Problem Solving **TOPS**

A Philosophy and A Part Of  
Continuous Improvement

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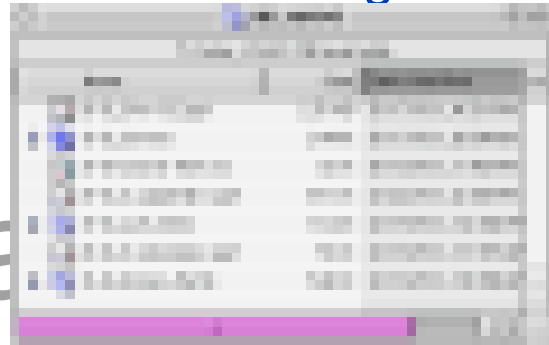
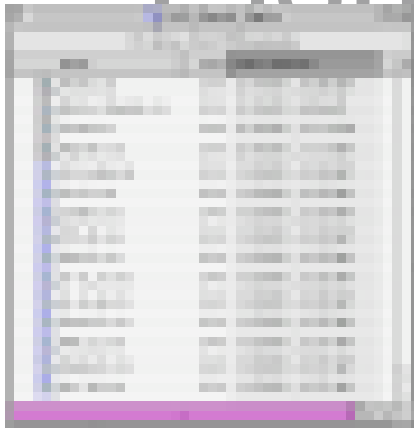
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*Notes & Commentary*

## Files Included In This Package

These files are currently included with this release of the implementation package:

- 8-D\_Pre-Gx.ppt is the main Powerpoint file.
- Updates are free for 1 year from purchase date.



As the set of files in this tome increases, the price may increase. Buy now to avoid!

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# Notes & Commentary

# The Red Road Graphics

- Files with the extension .swf are Macromedia Flash files (<http://macromedia.com>). They are Courtesy of *The Red Road* (<http://www.sci.fi/~leo/>). I have included them as I am a graphics 'nut' and I really believe they help a lot of text challenged people, myself included, understand several basic concepts.
- I develop on a *Macintosh* using Office 98. Work is checked for compatibility on a Compaq PC running Windows 98 and Office 2000. The free download version of **Quicktime** (<http://www.apple.com/quicktime/>) plays .swf files on both my Compaq peecee and on my Macintosh. The latest version of Quicktime is a 'beta' release of version 5 in which Flash is incorporated.
- Both computers have Shockwave and the Flash player installed, as well as the latest Quicktime. All are free downloads. There is a Quicktime Pro edition for sale, but you only need the free downloadable version.
- On the Macintosh platform, the files play in Powerpoint like movies when in the SlideShow mode. On the PeeCee platform they do not. The Macintosh version of Powerpoint handles .swf files as 'movies' while the PeeCee does not appear to.

## Notes & Commentary



Made With A Mac

## About .swf Files - 1

- If you have the Shockwave Flash plug-in for Internet Explorer installed, you can see these files online at: [http://Elsmar.com/pdf\\_files/](http://Elsmar.com/pdf_files/). All the .swf files are there (look by name). Using Explorer on both my PeeCee and my Mac, clicking on the file in my browser opens and allows you to 'play' the file. I don't have Netscape for the PeeCee so I can't check that, but *on my Mac I cannot get the Netscape browser to play the file even though the plug-in is installed - so I doubt it will play with Netscape on the PeeCee.*

- NOTE: Microsoft's Photo Editor does not 'play well' with *animated* gif files. It is not animated gif aware'. You can see the first frame, but that's it.

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## About .swf Files - 2

- To Play Animations From Within Powerpoint on a PeeCee
  - *Except* for the **Histogram** animation, I have included a .gif file as a counterpart to each .swf file. Any program which will play animated gif files will play these files. *You can make the animations play in SlideShow mode* in Powerpoint by first setting up the file links. Go to each **presentation slide** which contains an animation and delete the animation. Then, go to the **Insert / Picture / From File ...** menu cascade. Releasing the mouse on the **From File...** menu line item will bring up a file browser. Browse to and click on the appropriate .gif file for that slide. *The animation will now play (continuous looping) in the SlideShow Mode.*
- The **controls** on the files only work if you are viewing the Flash files!!! The controls on the gif files do NOT work!!!
- The location of .mov (Quicktime movie) and .ani (Windows animation/movie) versions of these .swf files:  
[http://www.Elsmar.com/pdf\\_files/Red\\_Road\\_Graphics/](http://www.Elsmar.com/pdf_files/Red_Road_Graphics/)



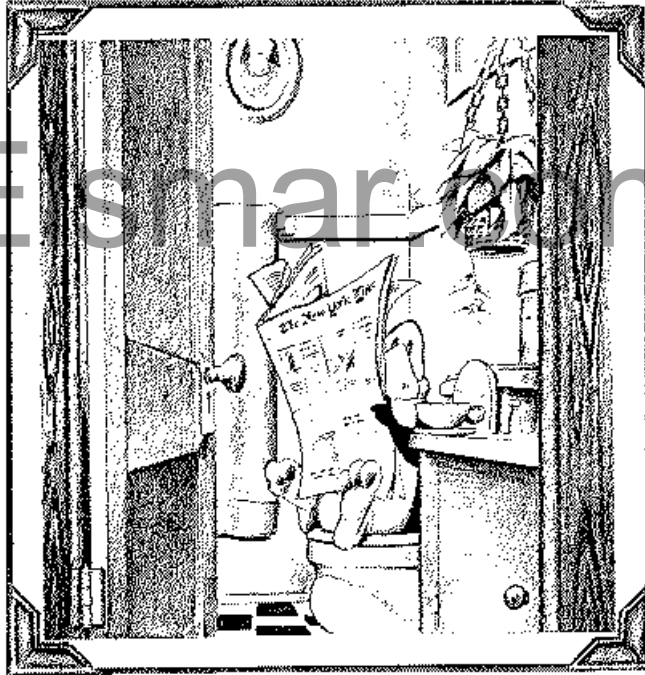
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Don't Let This Happen To YOU!



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# Origins: Mil-Std 1520

MIL-STD-1520C  
27 JUNE 1986

SUPERSEDING  
MIL-STD-1520B  
3 JULY 1980

- The origins of the 8-D system actually goes back many years.
- The US Government first 'standardized' the system in Mil-Std-1520 "Corrective Action and Disposition System for Nonconforming Material"
- Mil-Std-1520 - First released: 1974
- Last Revision was C of 1986
- Canceled in 1995

## MILITARY STANDARD

**Corrective Action**  
and  
Disposition System  
for  
Nonconforming Material



NO DELIVERABLE DATA  
REQUIRED BY THIS DOCUMENT

AREA QCIC

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

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## Notes & Commentary

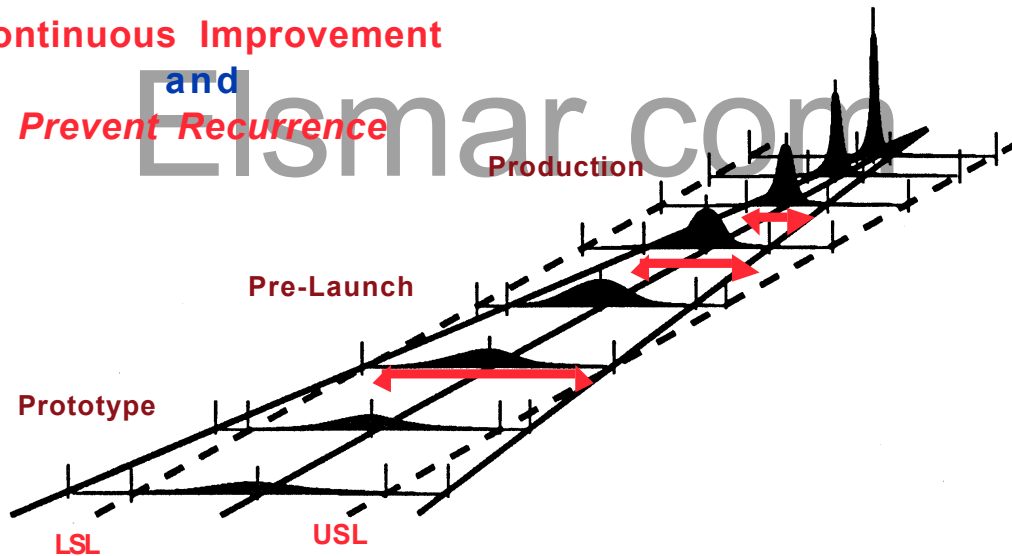
While Ford has made the 8-D system popular in automotive manufacturing, it is not a new system or, by any means, a Ford system. From Mil-Std-1520C:

### 1. Scope

1.1 Purpose. This standard sets forth the requirements for a cost-effective corrective action and disposition systems for nonconforming material. It defines requirements relative to the interface between the contractor and the contract administration office on nonconforming material. This standard sets forth the DOD contracting activity requirements for a properly constituted Material Review Board. The primary purposes of the corrective action and disposition system are *to identify and correct causes of non-conformances, prevent the recurrence of wasteful nonconforming material, reduce the cost of manufacturing inefficiency, and foster quality and productivity improvement.*

## The Target & Goal

Continuous Improvement  
and  
Prevent Recurrence



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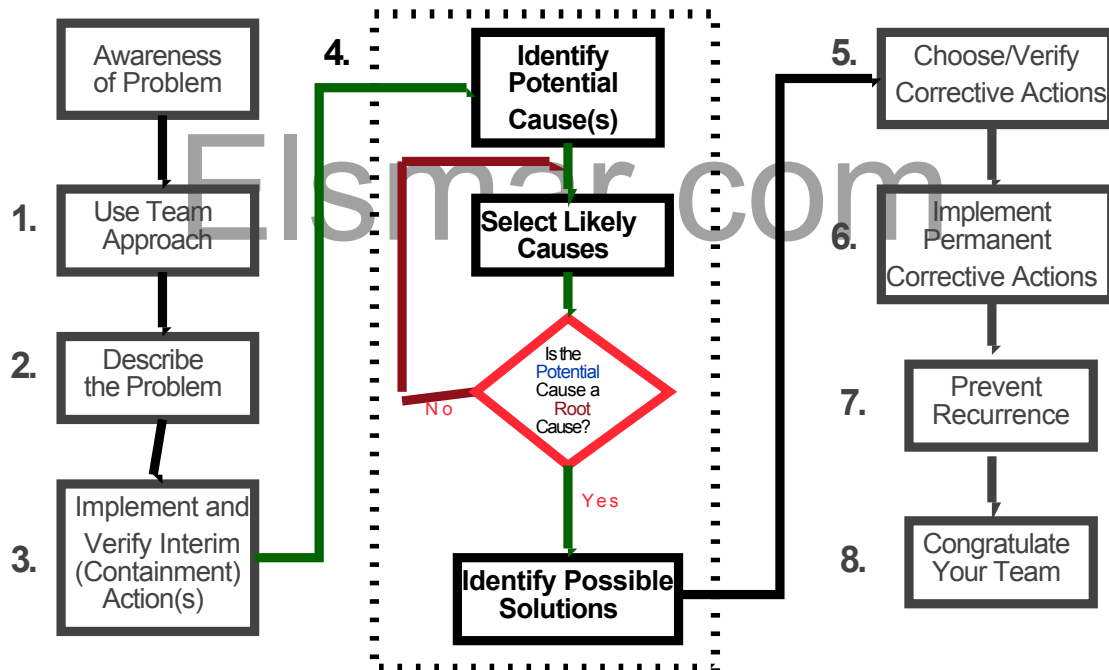
## Notes & Commentary

The ultimate goals of 8-D Problem Solving are:

Preventing Recurrence  
and  
Continuous Improvement  
Through the Use of Data



## The 8-D System



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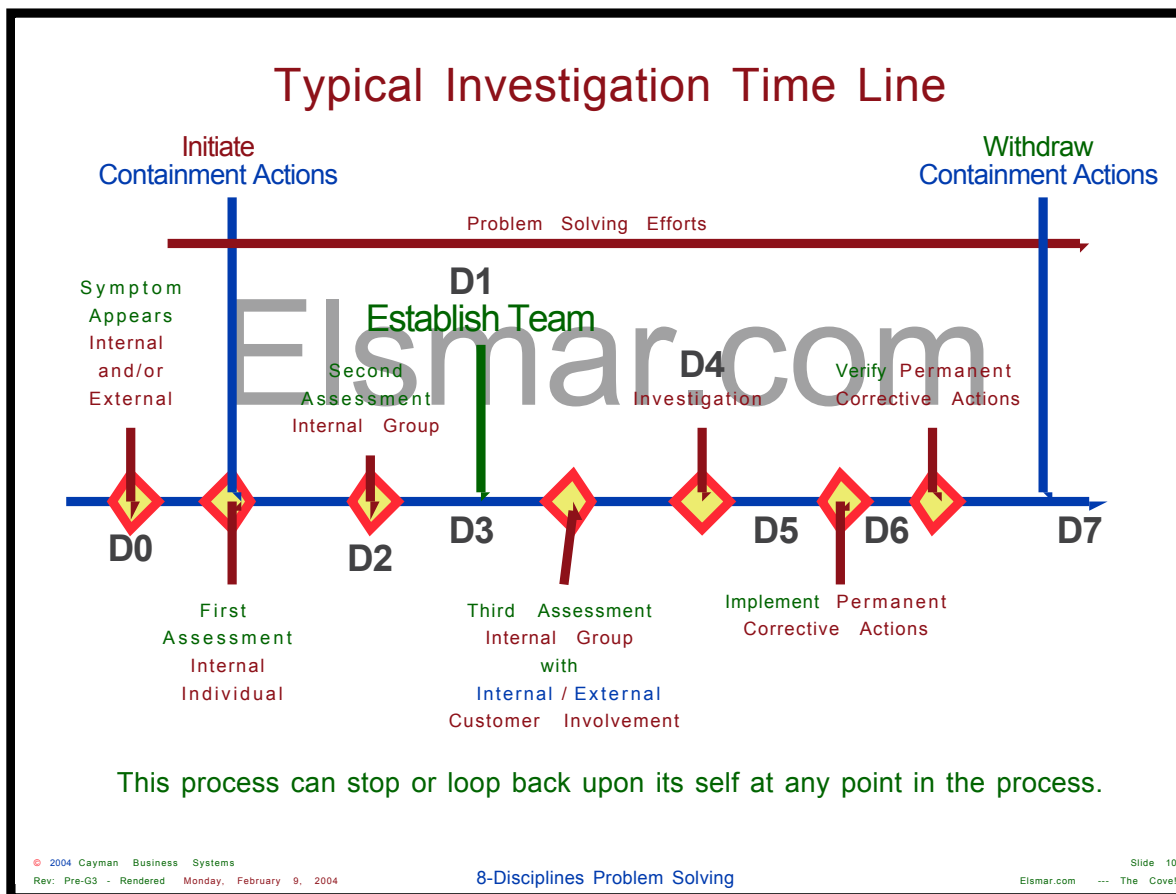
## Notes & Commentary

### The 'D' in 8-D stands for Disciplines

In the early part of this course, we will talk a lot about Teams. Teams are important. Why do you think this is so?

Normally people in a company have skills, experience and abilities which complement each other. A company as a whole is complex - a set of systems with different functional experts in different areas. The areas complement each other and many have interactions. Quality affects manufacturing. Design affects quality. Quality affects design.

The 8-Disciplines methodology requires a team effort to ensure that there is communication between interested parties' and that interactions are identified and effects assessed.



## Notes & Commentary

While the sequence above appears clear, some things will be happening concurrently.

Important terms / concepts to understand:

- Containment
- Escape Point
- Escape Path
- Interim Corrective Action
- Root Cause
- Permanent Corrective Action
- Prevent Recurrence

# A Nonconformance Database

This nonconformance database was written for an automotive manufacturer as is rather evident by the documentation addressed (circled in red).

For other companies, it is a matter of looking at your documentation and system(s) and aligning appropriate documents.

## Nonconformance & Corrective Action Database

Data Entry Base Record			
Hold Tag No.:	PN:	Customer:	
Hold Tag Issued By:	Date Code:	Rev:	Customer Part No.:
Hold Tag Issue Date:	Product:	(If Applicable)	
Part Description:	Qty. On HOLD:	Initial Disposition:	
Defect Code:	No. Of Carriers:	If Rework, Rework Instruction No.:	
Material Location:	Qty. Checked:	If Use-As-Is, Deviation/Waiver No.:	
Area Supervisor:	Qty. NC:	Number Good:	
Nonconformance (Reason):		If SORT: Number Bad:	

Analysis	Response Team Members:
Process Reviewed By:	
Process Adequate? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Revised <input type="radio"/> N/A	
Inspection Instruction Reviewed By:	
Inspection Adequate? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Revised <input type="radio"/> N/A	
PCMEA Reviewed By:	
PCMEA Adequate? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Revised <input type="radio"/> N/A	
Process Control Plan Reviewed By:	
Process Control Plan Adequate? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Revised <input type="radio"/> N/A	
Process Flow Diagram Reviewed By:	
Process Flow Diagram Adequate? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Revised <input type="radio"/> N/A	
Tooling/Gaging Reviewed By:	
Tooling/Gaging Adequate? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Revised <input type="radio"/> N/A	
Print(s) Reviewed By:	
Print(s) Adequate? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Revised <input type="radio"/> N/A	
	Defective Component PN: Analysis Defect Code:
	Defective Component Name:
	Stock Purged? <input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> N/A

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This is the 'front end' of the database. The 'standard' 8-D fields are not shown here. See NC\_DBASE.pdf for the complete record.

# Analysis vs. Action

The 'disciplines' which make up the 8-D process are divided into **Analysis** and **Action** steps.

## Analysis Steps

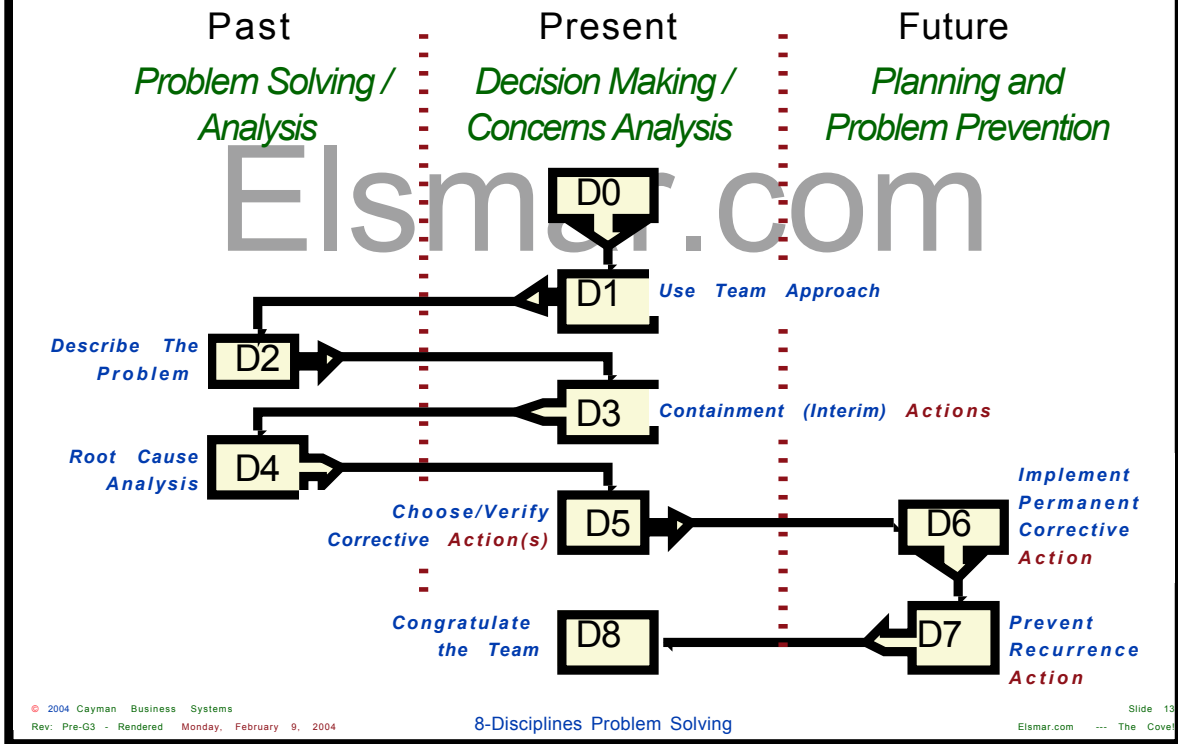
- △ D2 **Problem Description Analysis** - A method to organize information about the Symptom into a Problem Description through the use of repeated WHYs.
- △ D4 **Root Cause Analysis** - A process to arrive at Root cause paths.

## Action Steps

- △ D3 **Containment** - An interim Verified action that will prevent the Symptom from reaching the customer.
- △ D5 **Choose Corrective Action** - The best corrective action which, when implemented in D6, permanently eliminates the Root Cause of the problem.
- △ D6 **Implement Corrective Action** - The best corrective action from D5 that is introduced into the process and Validated over time.
- △ D7 **System Preventive Action** - Actions which address the system that allowed the problem to occur.

*Notes & Commentary*

# Process Tools



*Notes & Commentary*

# Process Tools

- **Problem Solving**

A systematic process which describes, analyzes and identifies Root Causes of a problem. It is used to solve 'past' actions that are now causing unwanted effects. Generally it takes more time, energy and resources to correct a problem than to prevent it. This tool is used in **D2** and **D4** for describing a problem and finding its Root Cause.

- **Decision Making**

A process used to select the best of various options. It addresses 'present' situations where the correct decision needs to be made the first time in order to implement appropriate actions. The tool is used at steps **D3** and **D5** for determining which **interim** and **permanent** corrective actions to implement.

- **Planning and Problem Prevention**

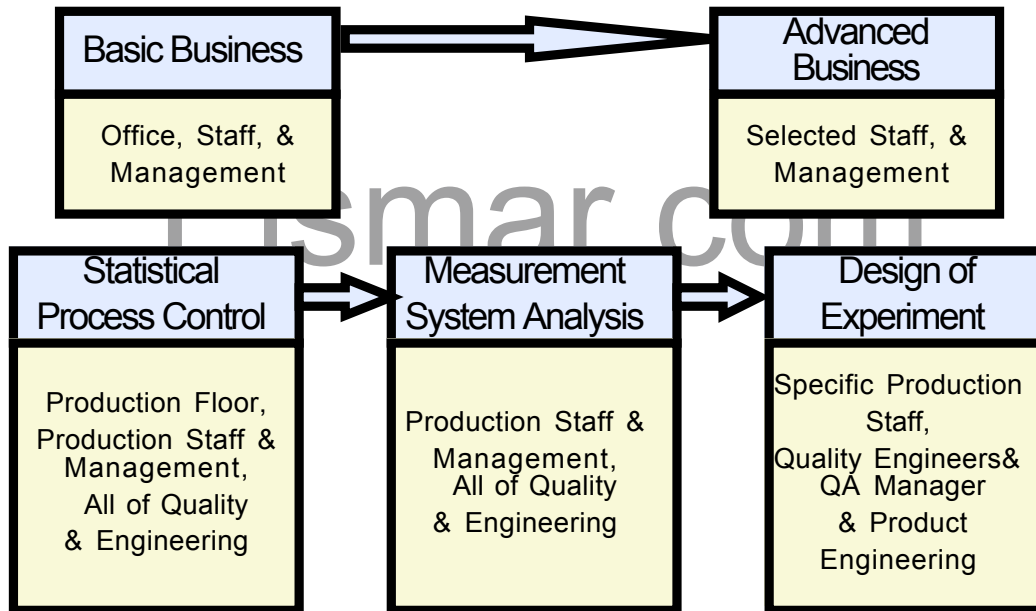
A process which looks into the future' to anticipate what might go wrong with a plan. The process requires team members to develop plans to prevent problems from happening or causing serious damage if they do happen. Generally, Planning and Problem Prevention provides the most cost effective way of avoiding problems. This tool is used in **D6** and **D7** for implementing permanent corrective actions and preventing recurrence.

- **Concerns Analysis**

A process which breaks down complex issues into manageable concerns, prioritizes them and assigns the proper process tools. Like Decision Making, it deals with 'present' situations and helps to step back from a long list of 'To Do' activities and assess the situation from a broader perspective. Most often used at **D0** and **D1** by management to help assemble a team, define its goals and objectives.

*Notes & Commentary*

## Recommended Statistical Courses



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# Statistical Tools

Tool	Purpose	8D Step
Trend Chart	Indicator to track magnitude of symptoms	D1 D2 D3 D4 D5 D6 D7 D8
Pareto Chart	Quantifier to prioritize and subdivide the problems	D2 D8
Paynter Chart	Indicator to monitor and validate the problems	D2 D3 D6 D8
Repeated Why	Method to move from symptom to problem description	D2
Information Database	Process to find root cause using Is/Is Not, Differences, Changes	D2 D4 D5 D6
Decision Making	Method to choose best action from among alternatives	D3 D5
Action Plan	Record of assignments, responsibilities and timing	D1 D2 D3 D4 D5 D6 D7 D8
EW8D	Report of problem solving process for management review	D1 D2 D3 D4 D5 D6 D7 D8

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# Statistical Tools 1

## Statistical Process Control

### 1. Cause and Effects Diagram

### 2. Operational Definitions

Lay Engineering Specs

### 3. Data Collection/Log/Check Sheet

### 4. Pareto Diagram

### 5. Histogram

Dot Plot

Stem and Leaf Plot

Box and Whisker Plot

### 6. Control Chart

X-bar R Chart

X-bar and s Chart

Median and R Chart

p Chart

c Chart

u Chart

np Chart

Run Chart (chart of individuals)

### 7. Scatter Diagram

Pie Chart

Bar Chart

Stacked Bar Chart

Pictorial Graph

Trend Chart

Time-line Chart

Process Flow Chart

## Ongoing Control - Monitoring

Statistical Process Control Charts

Quality Performance Indicators

Histograms

Check Sheets

Log Sheets

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## Notes & Commentary

There are many, many analysis tools. The intent of this course is to focus on several which are more specific to an 8-D problem solving task:

- Information Database
- Decision Making Work Sheet
- Is / Is Not

You will find that the many other analysis tools, and solution tools, will be important, nay invaluable, however the applicability of any one tool will depend upon the specific problem being analyzed as well as the available expertise. For example, not all companies have an employee who is versed in Design of Experiments or FMEAs.

Unfortunately, it is well beyond the scope of this course to attempt to train all of these methodologies.

# Statistical Tools 2

## Quality Performance Indicators

Plant Trend Charts  
Warranty Charts  
Engineering Specification Testing  
Fleet Testing  
Test Track  
Burn-In Results

## Verification, Prevention and Investigation

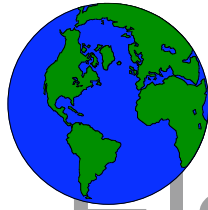
Process Capability/Potential Studies  
Statistical Process Control Charts  
Quality Performance Indicators  
Histograms  
Check Sheets  
Log Sheets  
Design Of Experiments  
Regression Analysis  
Process Flow Chart  
Taguchi (screening) Analysis

## Contingency and Forecasting

Failure Modes and Effects Analysis  
Design of Experiments  
Regression Analysis  
Reliability Studies

*Notes & Commentary*

# Universe, Populations & Samples



## Universe:

The collection of **all** elements.

## Population:

The set of objects of interest.



## Sample:

A subset of objects taken from the population.

## Random Sample:

All possible samples of the same size have an equal chance of occurring.

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# Notes & Commentary

# Interpreting Statistics

## Key Terms:

**Hits:** The total number of files requested from the server.  
**Bytes:** The amount of information transferred in filling those requests.  
**Visits:** The (approximate) number of actual individual visitors.  
**PViews:** The number of Web pages viewed by those visitors.

The bar graphs below are based upon number of visitors.

## Monthly Statistics

Hits	Bytes	Visits	PViews	Month
35,901	377,732,356	2,001	0	Aug 1997
80,718	822,036,414	3,768	0	Sep 1997
97,224	1,014,449,988	4,342	0	Oct 1997
90,037	926,226,241	4,780	0	Nov 1997
86,330	863,277,442	4,955	0	Dec 1997
37,620	468,643,785	2,119	0	Jan 1998
115,315	1,511,056,772	6,490	0	Feb 1998
76,813	1,240,543,286	6,928	0	Mar 1998
44,330	912,588,906	6,936	0	Apr 1998
48,612	1,034,397,477	7,265	0	May 1998
65,507	1,220,100,449	8,028	6,670	Jun 1998
185,018	2,235,857,995	7,875	51,654	Jul 1998
166,903	2,060,462,718	7,240	45,507	Aug 1998
163,879	2,170,173,835	7,709	45,457	Sep 1998
205,390	2,700,239,218	9,290	56,534	Oct 1998
166,203	1,965,080,133	7,411	46,148	Nov 1998

[\[ Return to Index \]](#)

# Notes & Commentary

# Interpreting Statistics

## Top 25 Most Frequently Requested 404 Files (Nov 1998)

Last Accessed	Hits	Bytes	File
00:49:30 25 Nov 1998	241	1,710,753	/robots.txt
19:00:47 24 Nov 1998	114	789,270	/qs.html
13:09:29 24 Nov 1998	105	744,828	/requirements.html
10:31:42 24 Nov 1998	70	494,333	/baldridge.html
15:39:40 23 Nov 1998	27	190,221	/cayman
00:21:19 25 Nov 1998	23	157,954	/iso.html
23:52:01 23 Nov 1998	15	105,343	/entry2.htm
21:39:29 24 Nov 1998	15	107,355	/cgi-bin/ultimate
16:37:32 12 Nov 1998	12	84,878	/fmea/fmea-f.ppt10.html
00:31:04 25 Nov 1998	12	79,227	/plexus.html
17:38:23 23 Nov 1998	10	70,564	/cgi-bin/ultimate.cgi
15:16:39 16 Nov 1998	10	64,913	/FMEA/FMEA-F.ppt02.html
05:08:46 20 Nov 1998	9	57,756	/qs9_manual.html
02:10:49 20 Nov 1998	9	63,910	/IASG_BIG.html
06:09:12 17 Nov 1998	8	57,256	/iso14000.html
16:37:37 22 Nov 1998	8	50,599	/qs9_imp.html
03:21:32 20 Nov 1998	8	57,256	/FMEA/FMEA-F.ppt1
19:38:17 16 Nov 1998	8	56,250	/FMEA/FMEA-F
19:38:25 16 Nov 1998	7	49,093	/FMEA/FMEA
04:29:28 20 Nov 1998	7	43,442	/FMEA/FMEA-F.ppt.html
13:59:44 24 Nov 1998	7	50,099	/APQP/APQP_out.ppt118.html
05:34:21 16 Nov 1998	6	42,942	/FMEA/
09:42:40 18 Nov 1998	6	36,285	/FMEA/FMEA-F.ppt03.html
14:05:35 24 Nov 1998	6	29,628	/iso_family.html
10:28:22 22 Nov 1998	6	42,942	/cgi-bin/board.cgi

*Notes & Commentary*

# Interpreting Statistics

## Complete 404 File Not Found Statistics (Nov 1998)

Last Accessed	Hits	Bytes	File
21:12:29 19 Nov 1998	1	7,157	/
04:17:15 20 Nov 1998	2	14,314	/------.class
10:18:19 23 Nov 1998	1	7,157	/4_18.html
10:12:50 23 Nov 1998	1	7,157	/4_2.html
01:49:02 13 Nov 1998	1	7,157	/9004-4.html
15:54:19 24 Nov 1998	6	42,942	/9810xx/htdocs981002/Cay_Pics/Cay_Pics/groucho.gif
00:50:04 25 Nov 1998	1,463	10,281,745	/9810xx/htdocs981002/Cay_Pics/smile.gif
08:49:07 17 Nov 1998	1	7,157	/APQP/
13:33:03 15 Nov 1998	1	7,157	/APQP/APQP_out.ppt.html
08:48:04 17 Nov 1998	1	7,157	/APQP/APQP_out.ppt02.html
08:49:00 17 Nov 1998	2	14,314	/APQP/APQP_out.ppt04.html
08:17:51 23 Nov 1998	2	14,314	/APQP/APQP_out.ppt05.html
16:58:43 23 Nov 1998	1	7,157	/APQP/APQP_out.ppt06.html
22:33:52 11 Nov 1998	1	7,157	/APQP/APQP_out.ppt110.html
22:38:38 11 Nov 1998	1	7,157	/APQP/APQP_out.ppt111.html
22:41:59 11 Nov 1998	1	7,157	/APQP/APQP_out.ppt112.html
22:51:15 11 Nov 1998	1	7,157	/APQP/APQP_out.ppt113.html
22:56:40 11 Nov 1998	1	7,157	/APQP/APQP_out.ppt114.html
23:01:47 11 Nov 1998	1	7,157	/APQP/APQP_out.ppt115.html
13:59:44 24 Nov 1998	7	50,099	/APQP/APQP_out.ppt118.html
19:09:04 17 Nov 1998	2	14,314	/APQP/APQP_out.ppt121.html
14:27:46 16 Nov 1998	1	7,157	/APQP/APQP_out.ppt13.html
16:57:20 20 Nov 1998	1	7,157	/APQP/APQP_out.ppt133.html
20:36:33 18 Nov 1998	1	7,157	/APQP/APQP_out.ppt46.html
06:47:06 18 Nov 1998	2	14,314	/APQP/APQP_out.ppt69.html
17:29:49 19 Nov 1998	1	7,157	/APQP/APQP_out.ppt89.html
13:29:54 24 Nov 1998	23	164,611	/APQP/Cay_Pics/groucho.gif
06:49:51 02 Nov 1998	1	6,654	/ASG_BIG.htm
08:01:27 03 Nov 1998	1	6,654	/ASG_BIG.html

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# Histogram Animation

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Play Histogram SWF File

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<http://www.sci.fi/~leo/>

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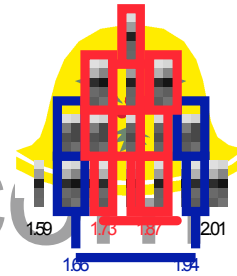
# Normal Distribution (Bell Curve)

This is a pattern which repeats itself endlessly not only with pieces of pie but in manufactured products and in nature. There is always an **inherent Variability**. Sometimes it's a matter of finding a measurement device **sensitive** enough to measure it.

Measurements may be in volts, millimeters, amperes, hours, minutes, inches or one of many other units of measure.

If you take a sample of a population (such as height) and you chart their distribution, you will end up with a curve that looks like a bell.

A **Distribution** which looks like a bell is a **Normal Distribution**. Normal Distributions are the **most common** type of distribution found in nature - but they are **not** the ONLY type of distribution.



Heights of men in the military:

Average height:	1.80 meters
Shortest:	1.59 meters
Tallest	2.01 meters

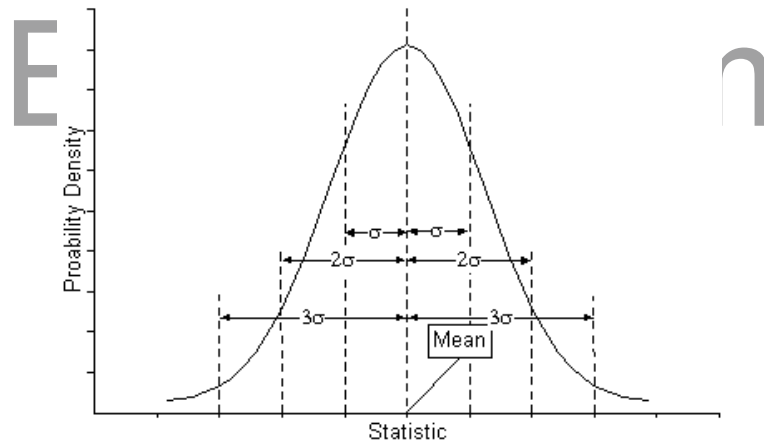
**Sixty-eight** percent are between 1.73 and 1.87 meters.

**Ninety-five** per cent are between 1.66 and 1.94 meters.

## Notes & Commentary



## Standard Deviation - A Measure of Dispersion



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To better understand Dispersion, Cp and Cpk, tune your browser to:  
<http://Elsmar.com/ubb/Forum10/HTML/000001.html>

[http://www.Elsmar.com/pdf\\_files/Cp.swf](http://www.Elsmar.com/pdf_files/Cp.swf), or

[http://www.Elsmar.com/pdf\\_files/Cp.gif](http://www.Elsmar.com/pdf_files/Cp.gif)

and

[http://www.Elsmar.com/pdf\\_files/Cpk.swf](http://www.Elsmar.com/pdf_files/Cpk.swf), or

[http://www.Elsmar.com/pdf\\_files/Cpk.gif](http://www.Elsmar.com/pdf_files/Cpk.gif)

Also interesting is:

[http://www.Elsmar.com/pdf\\_files/ProcessLoop.swf](http://www.Elsmar.com/pdf_files/ProcessLoop.swf) / .gif

**\*\*Files with the .swf extension are Flash files**

# Basic Terms

$\bar{X}$  = X-Bar = Average

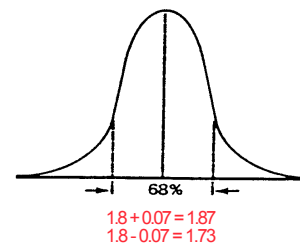
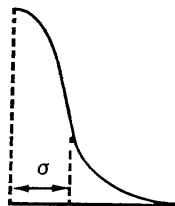
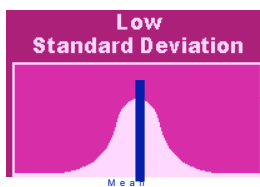
This is X-Bar. It tells us the **Average** of a group of numbers (in this case average height). X-Bar is the middle of the curve where we have the largest percentage of men.

$\sigma$  = sigma = Standard Deviation

$\sigma$  is the Greek letter **Sigma**. It is the distance from the center of the curve to the point where the curve stops curving downward and starts curving outward. We're interested in points at 1, 2 and 3 **Standard Deviations** from the **Mean** (the center).

If we measure 1 Standard Deviation on each side of the center of the curve, 68% of the Area will be between the lines drawn through these points.

The **Human Proportions** table tells us the Standard Deviation ( $\sigma$  - dispersion) of men's heights is 0.07 meters, so by simple addition and subtraction we know that 68% of the men are between 1.73 and 1.87 meters.



*Notes & Commentary*

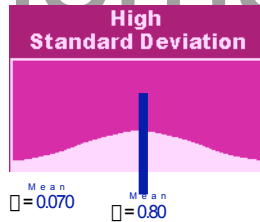
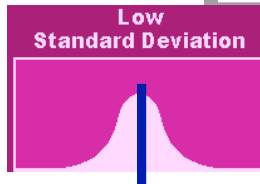
# Standard Deviation

## Human Proportions

Height	Men		Women	
	X-Bar	sigma	X-Bar	sigma
Standing	1.8	0.07	1.6	0.05
Sitting	0.9	0.03	0.86	0.02

$\bar{X}$  = X-Bar = Mean

$\sigma$  = sigma = Standard Deviation



Mean  
 $\sigma = 0.070$

Mean  
 $\sigma = 0.80$

$$SD = \sqrt{\frac{\sum (X - \bar{X})^2}{N}}$$

Finding the Standard Deviation

The most common measure of **dispersion**. The standard deviation is the square root of the **variance**, which is the sum of squared distances between each datum and the **mean**, divided by the **sample size** minus one. For a tiny sample of three values (1,2,15), the **mean** is:

$$(1 + 2 + 15) / 3 = 6$$

and the **variance** is

$$((1 - 6)^2 + (2 - 6)^2 + (15 - 6)^2) / (3 - 1) = 61$$

The standard deviation ( $\sigma$ ) is not a very helpful measure of spread for distributions in general. Its usefulness is due to its intimate connection with a special type of distribution, namely to the **normal distribution**.

The standard deviation is more sensitive to a few extreme observations than is the mean. A skewed distribution with a few values in the 'long tail' will have **large standard deviation** and it will not provide much helpful information in such cases.

*Notes & Commentary*

Cp Animation

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Play Cp SWF File

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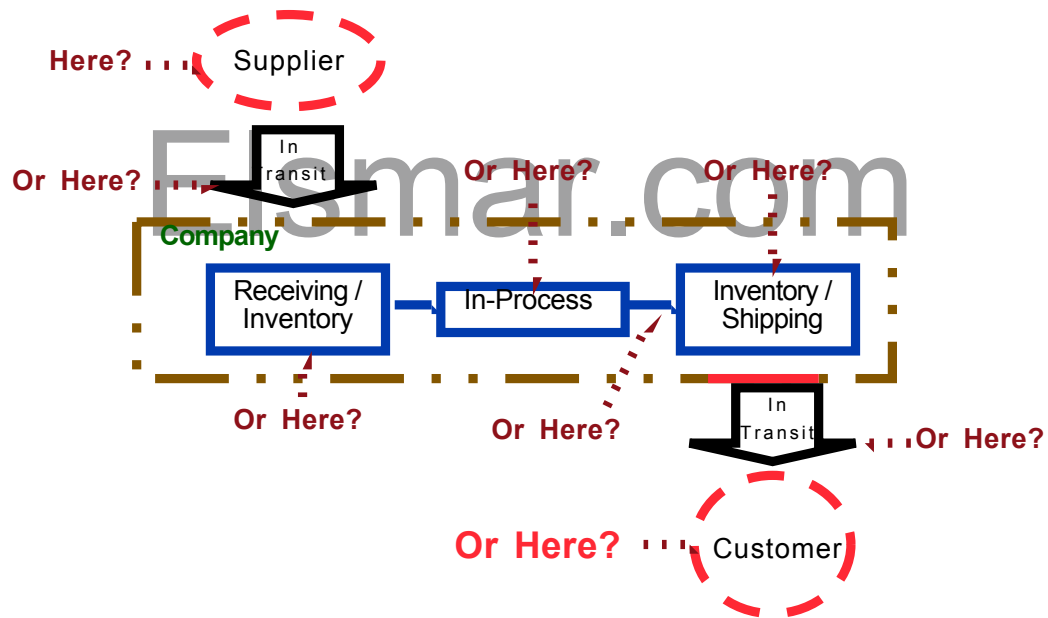
## Notes & Commentary

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Problem Identified

Houston! We've Got A Problem!

*Notes & Commentary*

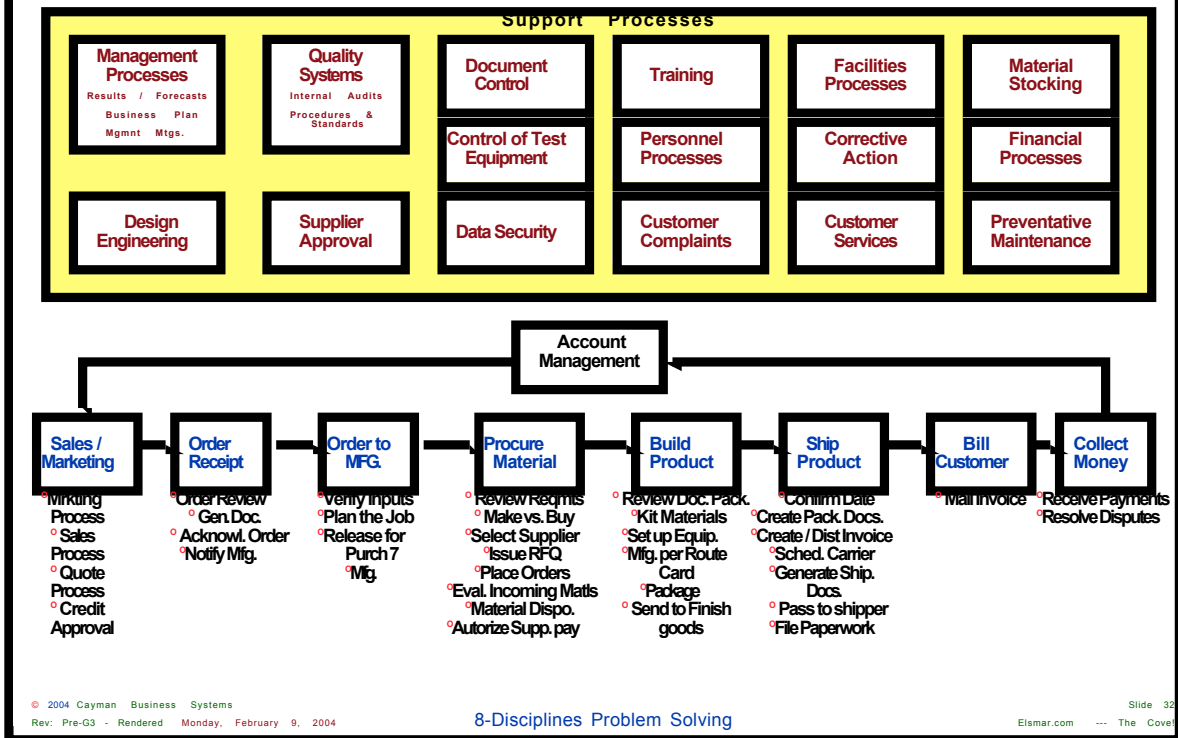
## Where Was The Problem Identified?



## Notes & Commentary

There are many places where a problem can be identified.

# Typical Top Level Operations Flowchart



## Notes & Commentary

What systems are involved?



## Process Flow Animation

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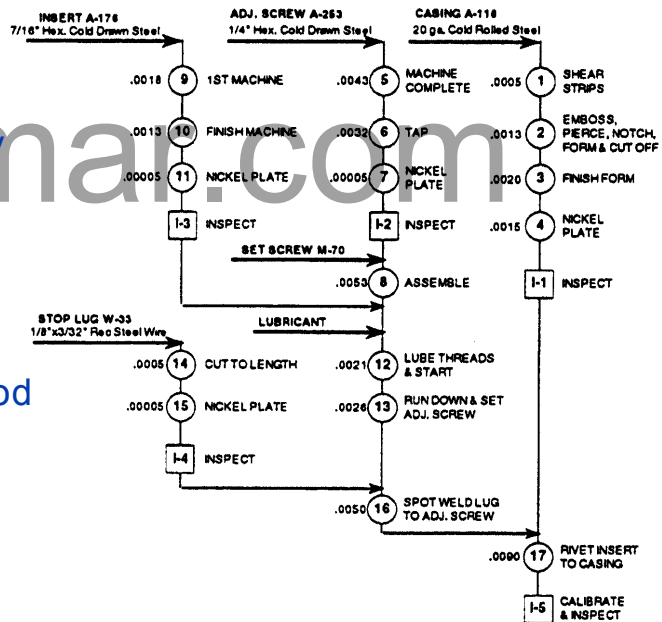
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## Notes & Commentary

# Early Process Flow Diagram

- Inspection Points
- Inspection Frequency
- Instrument
- Measurement Scale
- Sample Preparation
- Inspection/Test Method
- Inspector
- Method of Analysis



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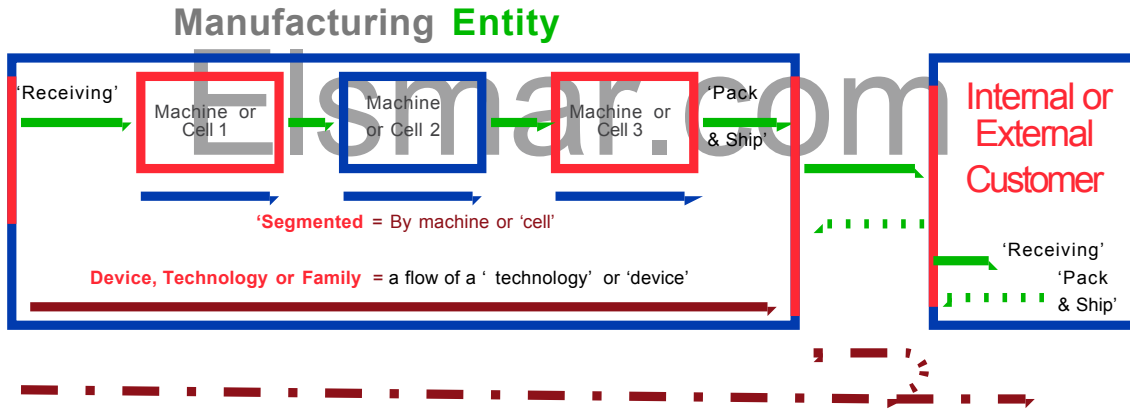
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*Notes & Commentary*

## Where Was The Problem Discovered?



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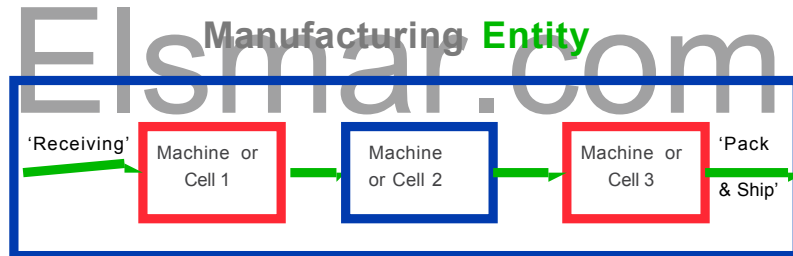
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# Notes & Commentary

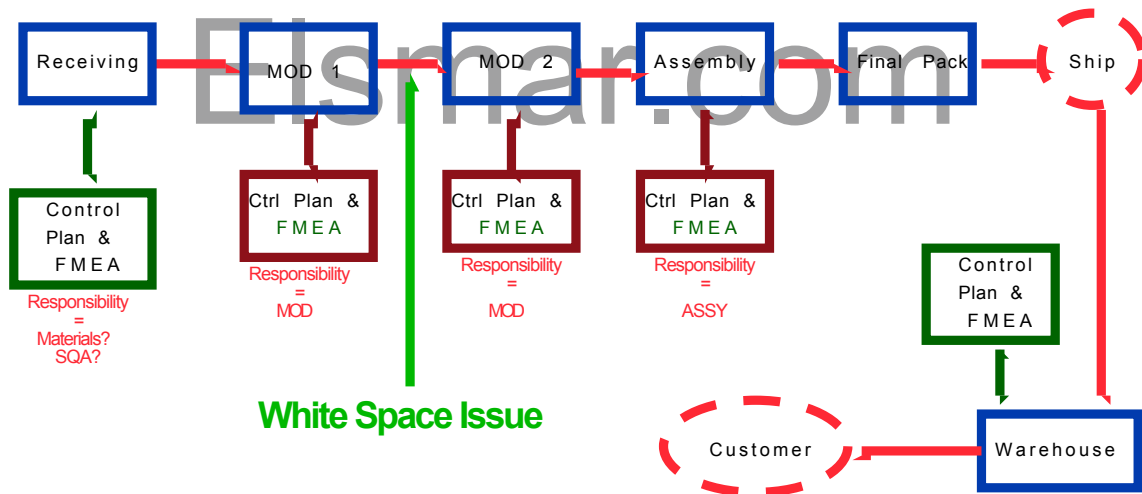
# Where Did The Problem Escape?



Are There **Multiple** Escape Points?  
What Is The Escape **Root Cause**?

*Notes & Commentary*

# White Space Issues



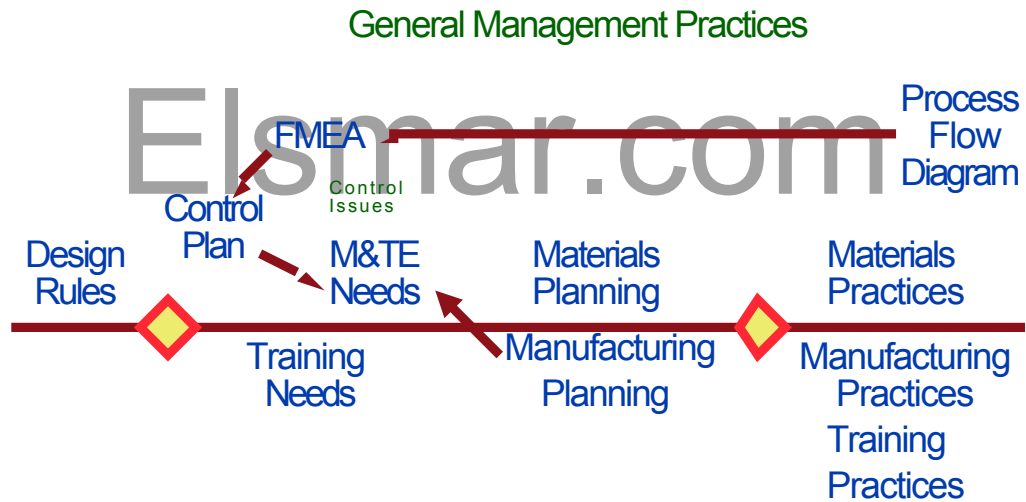
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*Notes & Commentary*

## Asking Why. How Far? Where Do I Look?



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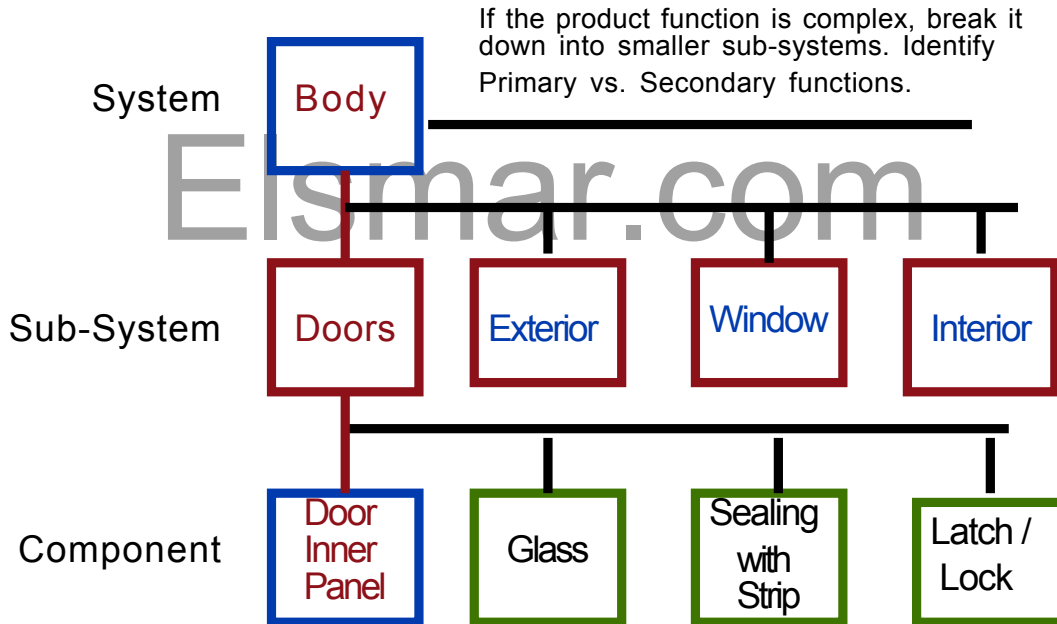
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Notes & Commentary

# Design Block Diagram Example



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## Cause and Effects Animation

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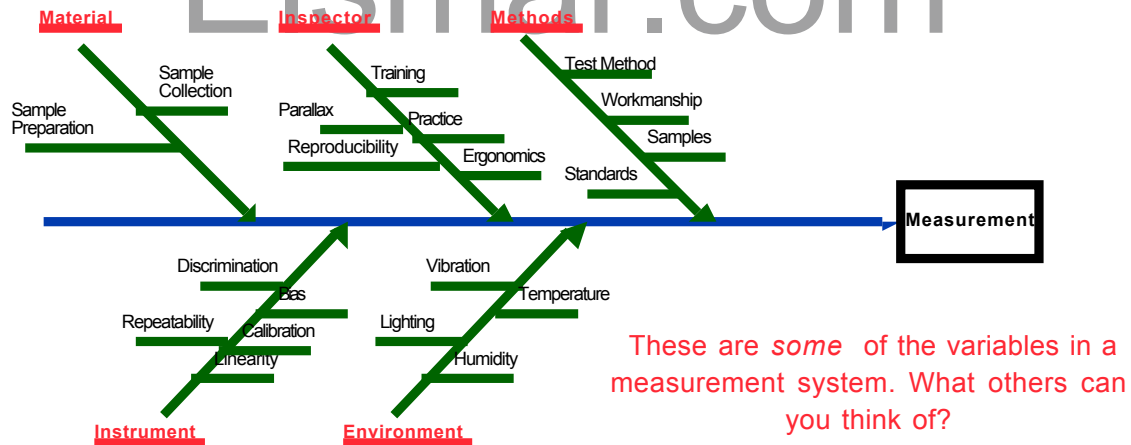
## Notes & Commentary



## Failure Modes In Measurement Systems

- Linearity
- Accuracy
- Repeatability
- Reproducibility
- Correlation for duplicate gages
- Gages may be needed prior to gage sign-off at subcontractor plant or any in-house pilot runs

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Notes & Commentary

# Process Variation

- Distinguishing between the types of causes is critical because the appropriate managerial actions are quite different for each. Without this distinction, management will never be able to tell real improvement from mere adjustment of the process or tampering.
- In practice, the most important difference to grasp first is the difference between special cause variation and common cause variation.
- The strategy for special causes is simple: Get timely data. Investigate immediately when the data signals a special cause is/was present. Find out what was different or special about that point. Seek to prevent bad causes from recurring. Seek to keep good causes happening.
- The strategy for improving a common cause system is more subtle. In a common cause situation, all the data are relevant, not just the most recent or offending figure. If you have data each month for the past two years, you will need to look at all of that data.

*Notes & Commentary*

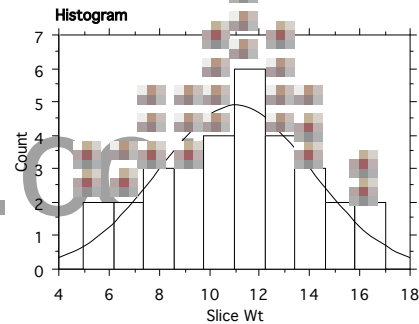
# Distributions From Variation

Sometimes you can look at two slices of pie and tell which is bigger. Sometimes you cannot.

Home Experiment: Slice a pie up into what you think are equal sized pieces and line them up according to size. Many look the same. If we want to arrange the pieces according to size, we need another way to tell how big each piece is. A weight scale will do quite well. Now - lets look at what we would find if we weighed each piece.

There are big and little pieces, but you can see that the number of pieces in each step of the graph (weight group) varies from the largest piece to the smallest piece in a fairly regular and symmetrical pattern. This is the **Distribution** of the weights. The curve is what we would expect if the Distribution was a **Normal** distribution.

Imagine doing this with 100 pies!



Frequency Distribution for Slice Wt

From ( $\geq$ )	To ( $<$ )	Count	Normal Count
5.000	6.200	2	.994
6.200	7.400	2	1.856
7.400	8.600	3	2.968
8.600	9.800	3	4.065
9.800	11.000	4	4.766
11.000	12.200	6	4.786
12.200	13.400	4	4.116
13.400	14.600	3	3.031
14.600	15.800	2	1.911
15.800	17.000	2	1.032
Total		31	29.527

*Notes & Commentary*

# Process Variation

- **All variation is caused.** There are specific reasons why your weight fluctuates every day, why sales go up, and why Maria performs better than Robert. Management must recognize that variations in production or quality within manufacturing or service processes can be viewed as "**special cause**" variations, which are best removed by team members operating the process and "**common cause**" variations, which require management action to change some inherent feature of the process. There are four main types of causes.
- **Common** causes are the myriad of **ever-present** factors (e.g., process inputs or conditions) that contribute in varying degrees to relatively small, apparently random shifts in outcomes day after day, week after week, month after month. **The collective effect of all common causes is often referred to as system variation because it defines the amount of variation inherent in the system.**
- **Special** causes are factors that **sporadically** induce variation over and above that inherent in the system. Frequently, special cause variation appears as an extreme point or some specific, identifiable pattern in data. Special causes are often referred to as **assignable** causes because the **variation they produce can be tracked down and assigned to an identifiable source.** (In contrast, it is usually difficult, if not impossible, to link common cause variation to any particular source.) Special Cause variation results from **events which are occurring outside the process.** For example, a relatively major **change in temperature or humidity** could cause significant variation (points outside control limits) in the process.

*Notes & Commentary*

# Causes of Variation

## Special (Assignable) Causes of Variation

**Special** causes are problems that arise in a **periodic** fashion. They are somewhat **unpredictable** and can be dealt with at the machine or operator level. Examples of special causes are operator error, broken tools, and machine setting drift. This type of variation is **not critical** and only represents a small fraction of the variation found in a process.

## Common Causes of Variation

**Common** causes are **problems inherent in the system itself**. They are **always present** and **affect the output** of the process. Examples of common causes of variation are poor training, inappropriate production methods, and poor workstation design.

As we can see, **common** causes of variation are **more critical** on the manufacturing process than special causes. In fact **Dr. Deming suggests that about 80 to 85% of all the problems encountered in production processes are caused by common causes**, while **only 15 to 20% are caused by special causes**.

## Notes & Comments

### Common Causes

When all variation in a system is due to **common causes**, the result is a **stable system said to be in statistical control**. The practical value of having a stable system is that the process output is predictable within a range or band. For example, if a stable order entry system handles 30 to 60 orders a day, it will rarely slip to fewer than 30 or rise to more than 60.

### Special (Assignable) Causes

If some variation is due to **special causes**, the system is said to be **unstable** since you **cannot predict when the next special cause will strike** and, therefore, cannot predict the range of variation. If a system is unstable and subject to special cause variation, its capability might sporadically (and unpredictably) drop sharply below or rise sharply.

# Facts About Causes of Variation

## Special Causes of Variation

- ☞ Accounts for 5-15% of quality problems.
- ☞ Is due to a factor that has "slipped" into the process causing unstable or unpredictable variation.
- ☞ Are unpredictable variations that are abnormal to the process including human error, equipment failure, defective/changed raw materials, acid spills, power failures, etc.; failure to remove them can result in corrosion, scale, metal fatigue, lower equipment efficiency, increased maintenance costs, unsafe working conditions, wasted chemicals, increased down-time (plant shut-down...), etc.
- ☞ **Removal of all special causes of variation yields a process that is in statistical control.**
- ☞ Correctable by local personnel.

## Common Causes of Variation

- ☞ Account for 85-95% of quality problems
- ☞ Are due to the many small sources of variation "engineered" into the process of the "system".
- ☞ Are naturally caused and are always present in the process because they are linked to the system's base ability to perform; it is the predictable and stable inherent variability resulting from the process operating as it was designed.
- ☞ Standard deviation,  $s$ , is used as a measure of the inherent process variability; it helps describe the well-known normal distribution curve.
- ☞ **Correctable only by management;** typically requires the repair/replacement of a system's component, or the system itself.

## Notes & Comments

# Tampering - Process Variation

- **Tampering** is additional variation caused by unnecessary adjustments made in an attempt to compensate for common cause variation.
- Tampering with a process occurs when we respond to variation in the process (such as by “adjusting” the process) when the process has not shifted. In other words, it is when we treat variation due to common causes as variation due to special causes. This is also called “responding to a false alarm,” since a false alarm is when we think that the process has shifted when it really hasn’t.
- In practice, tampering generally occurs when we attempt to control the process to limits that are within the natural control limits defined by common cause variation. We try to control the process to specifications, or goals. These limits are defined externally to the process, rather than being based on the statistics of the process.

## Notes & Commentary

**Deming showed how tampering actually increases variation.** It can easily be seen that when we react to these false alarms, we take action on the process by shifting its location. Over time, this results in process output that varies much more than if the process had just been left alone.

Rather than using the suggested control limits defined at  $\pm 3$  standard deviations from the center line, we instead choose to use limits that are tighter (or narrower) than these (sometimes called Warning Limits). We might do this based on the faulty notion that this will improve the performance of the chart, since it is more likely that subgroups will plot outside of these limits.

For example, using limits defined at  $\pm 2$  standard deviations from the center line would produce narrower control limits than the  $\pm 3$  standard deviation limits. However, you can use probability theory to show that the chance of being outside of a  $\pm 3$  standard deviation control limit for a Normally-distributed statistic is 0.27% if the process has not shifted. On average, you would see a false alarm associated with these limits once every 370 subgroups ( $=1/0.0027$ ). Using  $\pm 2$  standard deviation control limits, the chance of being outside the limits when the process has not shifted is 4.6%, corresponding to false alarms every 22 subgroups!

# Structural Variation

- **Structural Variation** is regular, systematic changes in output. Typical examples include seasonal patterns and long-term trends.

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## Notes & Commentary

**Structural Variation** is of special note here. Some folks break out variation into four categories:

Special Cause

Common Cause

Tampering

Structural Variation

You can consider both Structural and Tampering variation as Common Cause variation. For example, the semi-conductor industry, as well as many other industries, have 'clean rooms' or other climate and interference controlled (noise, vibration, temperature, humidity, air particle level, etc.) facilities. By not operating in air conditioning during the summer, management has built into the system a significant source of pollution / interference.



## Problem vs. Symptom

- **At this point it is important to distinguish between a problem and a symptom.** A symptom, for example, could be a split in a seam.
- Generally, there are a **series of problems associated with a process that causes a symptom** (in this case the seam split). A symptom often illustrates a 'gap' between the desired quality (of the seam) and its actual quality. The seam split because of a problem in the process or in the design.
- **Every company has its own internal system for appraising symptoms and problems.** Sometimes a symptom occurs where 1 person can evaluate the problem and address it. Other times the symptom is significant and requires a team to investigate and remove the cause.

*Notes & Commentary*

# When An 8-D Is Necessary

- Using 'Good Judgment' is the first step in deciding when to start an 8-D.
- Often, however, an 8-D is a customer requirement in response to a problem: Feedback from the customer that there is a concern with the product. Sometimes the concern shows up as a Symptom that has been detected by the customer.
- Ideally, a measurable will indicate when an 8-D should be started. When an undesirable trend in a process develops, corrective action can be taken to reduce the cause of the variation before a symptom occurs in the process and escapes to the customer.
- If the undesirable trend triggers questions, a decision must be made whether the symptom can be fixed by an individual or whether the symptom requires further analysis. Further analysis typically indicates it's time to assemble an 8-D problem solving team.

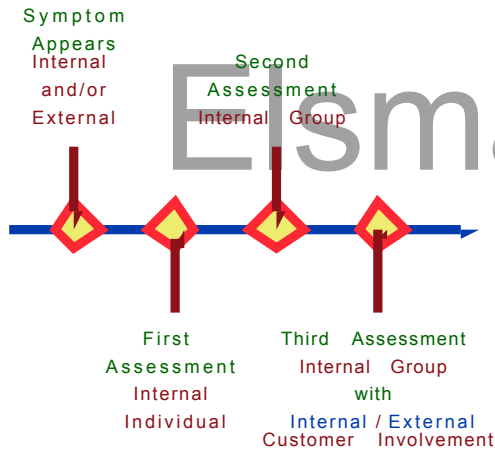
*Notes & Commentary*

## When An 8-D Is Necessary

- At this point, each of you (in your thoughts) is wanting the instructor to provide a black & white explanation of when a formal 8-D is required. Unfortunately, the answer is that the only time an 8-D is 'required' is when a customer requires it.
- Each company provides an internal threshold. It is typically somewhat subjective. There is no 'absolute' in so far as when or how far. Many companies use a Review Board. But - each has it's own path.

*Notes & Commentary*

# When An 8-D Is Necessary



There are typically several **assessment points** in a company's evaluation of a symptom.

Each assessment is a **decision point** - first by one or more individuals, then by 'official' groups.

At each point, '**reason**' is used to decide whether a 'full' 8-D is necessary.




*Notes & Commentary*

# Verification vs. Validation

**V**erification and **V**alidation are often not well understood. Verification and Validation work together as a sort of 'before' (Verification) and 'after' (Validation) proof.

- **Verification** provides 'insurance' at a point in time that the action will do what it is intended to do without causing another problem. **Predictive.**
- **Validation** provides **measurable** evidence over time that the action worked properly.

Incidents							
Problems:	July	Aug	Sept	Oct	Nov	Dec	Total
Traffic jam on Hiway	90	84	4	3	0		9
Busses Late	30	30	9	8	30		3
Not Enough Parking	17	16	17	8	0		1
Bad Weather	9	10	20	21	9		
Road Construction	4	0	0	0	21		
	150	140	50	40	60		15

 = Containment Action: Change Shift Starting Time  
 = Corrective Action: Open second gate, change shift starting times back to 'normal'.  
 = Corrective Action: Task Group established.

Step	Process	Purpose
D3	Verification	That the containment action will stop the symptom from reaching the customer.
	Validation	That the containment action has satisfactorily stopped the symptom from reaching the customer according to the same indicator that made it apparent.
D4	Verification	That the real Root Cause is identified.
D5	Verification	That the corrective action will eliminate the problem.
D6	Validation	That the corrective action has eliminated the problem according to the same indicator that made it apparent.

*Notes & Commentary*

# Investigative Questions

**10-10-321 NOW Offers You  
50% Off On All Calls.**

**What does this statement tell you?**  
**What information does it really contain?**  
**What questions does it bring to mind?**

*Notes & Commentary*

# Investigative Questions

What other details might you want to know about?

What was the program before?

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**10-10-321 NOW Offers You  
50% Off On All Calls.**

50% off of what?

All calls everywhere?

What 'conditions' apply?

Time of day? Day of week? Is this a 30 day 'teaser'?

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## D1

### Use Team Approach

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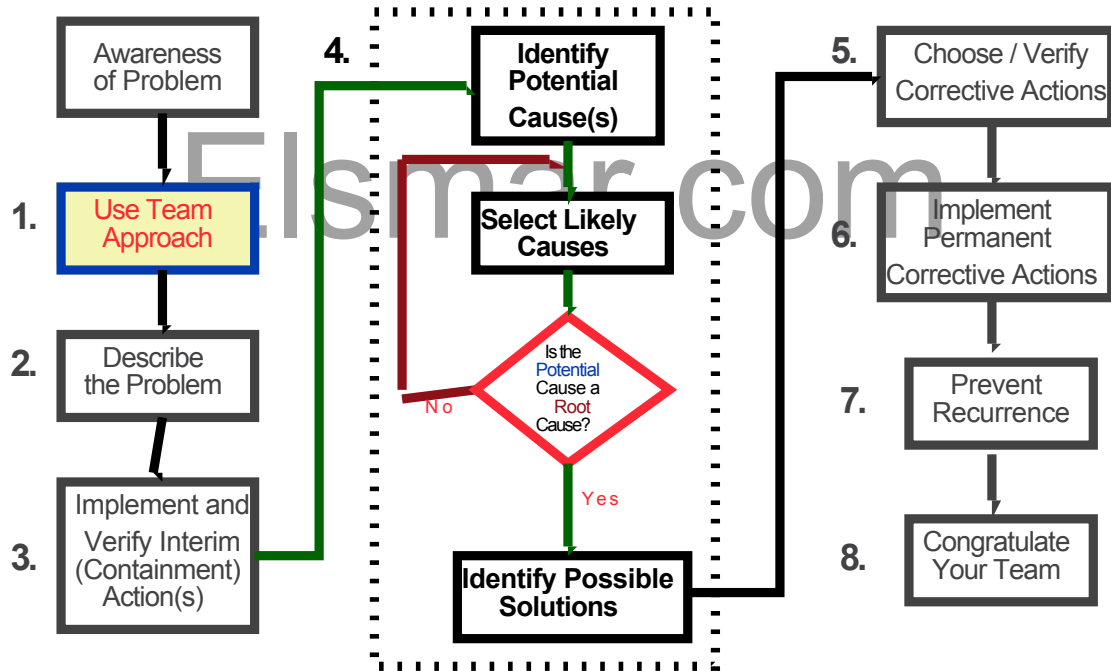
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# The 8-D System



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# Team Approach

- When a problem cannot be solved quickly by an individual, it is necessary to form a **Team**. The team will engage in the investigation and resolution of the problem. Many factors are critical to establish a group and to ensure that the group can work effectively together. Using a team approach is not just a step in the problem solving process, but an overriding framework for decision making.
- It is necessary to reevaluate team membership continually.
- **Model for Effective Teamwork:**
  - Structure
  - Goals
  - Roles
  - Procedures
  - Interpersonal Relationships

## Notes & Commentary

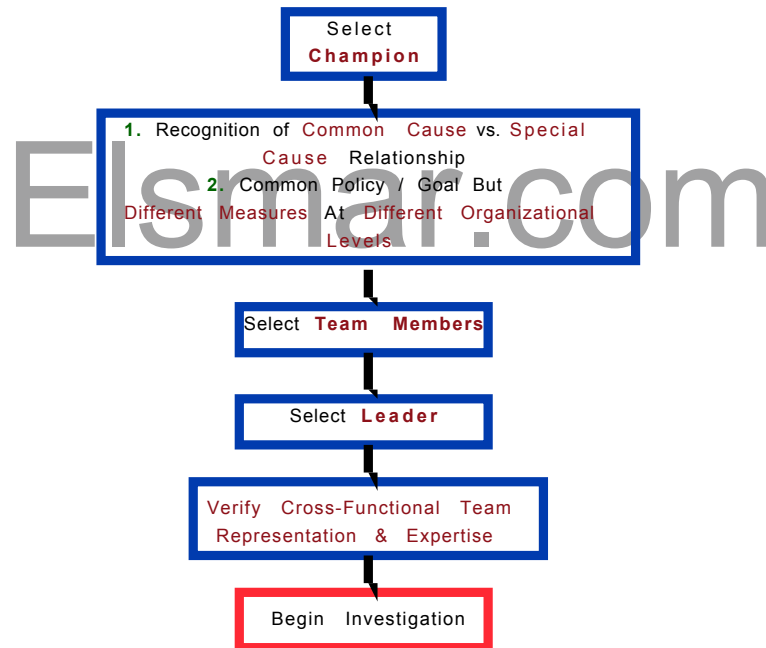
Why teams? Why cross-functional teams?

Cross-functional teams minimize visible layers of supervision originating solely from any specific functional group - Engineering, Manufacturing, Quality, etc.

A Team is a small group of folks with the process / product knowledge, **allocated time, authority** and skill(s) in the required technical disciplines to solve the problem and implement corrective actions. The group must have a designated **champion**.

Team members must be empowered with the potential to 'change the rules'.

# Establishing A Team (Flow)



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## Notes & Commentary

**Common** causes are the myriad of **ever-present** factors (e.g., process inputs or conditions) that contribute in varying degrees to relatively small, apparently random shifts in outcomes day after day, week after week, month after month. The collective effect of all common causes is often referred to as **system variation** because it defines the amount of variation inherent in the system.

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# The Team - Basics

- **What is a Team?**

Two or more individuals who coordinate activities to accomplish a common task or goal.

- **Maintaining Focus**

A separate team for each product or project.

- **Brainstorm**

Brainstorming (the Team) is necessary as the intent is to discover many possible possibilities.

*Notes & Commentary*

# Brainstorming

## What is Brainstorming?

- Brainstorming is a method for developing creative solutions to problems. It works by focusing on a problem, and then deliberately coming up with as many deliberately unusual solutions as possible and by pushing the ideas as far as possible.
- One approach to brainstorming is to 'seed' the session with a word pulled randomly from a dictionary. This word as a starting point in the process of generating ideas.
- During the brainstorming session there is no criticism of ideas - the idea is to open up as many possibilities as possible, and break down preconceptions about the limits of the problem.
- Once this has been done the results of the brainstorming session can be analyzed and the best solutions can be explored either using further brainstorming or more conventional solutions.

*Notes & Commentary*

# How To Brainstorm

The following rules are important to brainstorming successfully:

- A leader should take control of the session, initially defining the problem to be solved with any criteria that must be met, and then keeping the session on course. He or she should encourage an enthusiastic, uncritical attitude among brainstormers and encourage participation by all members of the team. The session should be announced as lasting a fixed length of time, and the leader should ensure that no train of thought is followed for too long. The leader should try to keep the brainstorming on subject, and should try to steer it towards the development of some practical solutions.
- Participants in the brainstorming process should come from as wide a range of disciplines with as broad a range of experience as possible. This brings many more creative ideas to the session.
- Brainstormers should be encouraged to have fun brainstorming, coming up with as many ideas as possible, from solidly practical ones to wildly impractical ones in an environment where creativity is welcomed.
- Ideas must not be criticised or evaluated during the brainstorming session. Criticism introduces an element of risk for a group member in putting forward an idea. This stifles creativity and cripples the free running nature of a good brainstorming session.
- Brainstormers should not only come up with new ideas in a brainstorming session, but should also 'spark off' from associations with other people's ideas and develop other people's ideas.
- A record should be kept of the session either as notes or a tape recording. This should be studied subsequently for evaluation. It can also be helpful to jot down ideas on a board which can be seen by all brainstormers.

*Notes & Commentary*

# Individual vs. Group Brainstorming

Brainstorming can either be carried out by individuals or groups:

- **Individual brainstorming** tends to produce a wider range of ideas than group brainstorming, but tends not to develop the ideas as effectively, perhaps as individuals on their own run up against problems they cannot solve. Individuals are free to explore ideas in their own time without any fear of criticism, and without being dominated by other group members.
- **Group brainstorming** develops ideas more deeply and effectively, as when difficulties in the development of an idea by one person are reached, another person's creativity and experience can be used to break them down. Group brainstorming tends to produce fewer ideas (as time is spent developing ideas in depth) and can lead to the suppression of creative but quiet people by loud and uncreative ones.
- Individual and group brainstorming can be **mixed**, perhaps by defining a problem, and then letting team members initially come up with a wide range of possibly shallow solutions. These solutions could then be enhanced and developed by group brainstorming.

*Notes & Commentary*

## Define Scope Of Team

- **Select** team members and functions
- **Define** roles and responsibilities
- **Identify** external customer needs, expectations and requirements
- **Identify** internal customer needs, expectations and requirements
- **Complete** preliminary studies
- **Identify** costs, timing and constraints
- **Identify** documentation process and method
- **Develop** investigation **plan**

*Notes & Commentary*



# Natural Work Group vs. Team

## Two Types of Team Structures

### Natural Work Group

### Task Team

#### Membership

Work area or unit.  
Representatives from support groups on as-needed basis.

Representatives who have key information or are stakeholders.

#### Member Selection

Participation is necessary.

Assigned by steering committee or upper management.

#### Project Identification

Assigned by management or identified by team and within its authority.

Assigned by, or negotiated with, steering committee or upper management.

#### Team Life Span

Ongoing.

Disbands when task is complete.

#### Leadership

Leader appointed by management.

Leadership shared or delegated by members.

*Notes & Commentary*

# Team Structure

- **Size**

Four to 10 members. Larger teams become less effective and have minimal commitment to the problem solving effort.

Larger teams should assess whether a steering committee and/or subgroups should be established.

- **Support Needed**

'Appropriate' levels of the organization must be represented.

- **Environment**

Meeting locations are critical to good teamwork. A site should be quiet and not disruptive to team members. A site near the work area permits easy data collection and customer interaction is beneficial.

*Notes & Commentary*

# Team Organization

## Cross-functional

- △ Design Engineering (Typically the leader)
- △ Quality Assurance
- △ Purchasing
- △ Manufacturing Engineering
- △ Material Control
- △ Sales/Marketing
- △ Etc.

- Participation appropriate for phase being conducted
- Resources - Team defines 'Needs'
- \*Should\* involve customer or subcontractor participation (not always feasible)

*Notes & Commentary*

## Decision Making Criteria / Model

- One person makes the decision
- One person consults the group, then makes the final decision
- Team or group makes decision based upon majority rule or consensus

## Notes & Commentary

The decision making model should be chosen at the beginning of the team formation. Because of potential political and internal power 'camps', it is often best for the champion to define which decision making model will be used.

# Roles In A Team

Several roles need to be established for the team. These roles are: **Leader**, **Champion**, **Record Keeper (Recorder)**, **Participants** and (if needed) **Facilitator**.

## Leader

Group member who ensures the group performs its duties and responsibilities. Spokesperson, calls meetings, establishes meeting **time/duration** and sets/directs **agenda**. Day-to-day authority, responsible for overall coordination and assists the team in setting goals and objectives.

## Record Keeper

Writes and publishes minutes.

## Champion

Guide, direct, motivate, train, coach, advocate to upper management.

## Participants

Respect each others ideas.

Keep an open mind.

Be receptive to consensus decision making.

Understand assignments and accept them willingly.

*Notes & Commentary*

## Inputs To Team

- Field service reports
- Problems and issues reported from Internal customers
- Internal evaluations using surrogate customers
- Road trips (e.g.: Struts)
- Management comments and/or direction
- Government requirements and/or regulations
- **Contract review**
- Input from higher system level or past QFD projects
- **Media** commentary and analysis
- **Customer** letters and suggestions
- Things gone Right/Wrong reports
- **Dealer** comments
- **Fleet operator** comments



*Notes & Commentary*

# Team Goals

For any group to come together as a team, it is critical that everyone be clear on the team's **goal(s)**. **All team member must share that goal.** If any team members have different goals or have individual goals different or separate from the stated goal, these should be communicated to the team to avoid road blocks to the success of the team.

The goal needs to be **clearly specified, quantifiable, and supported** by all team members. The goal should be challenging, but **still be attainable**. By writing (**documenting**) the team's goal, all individuals on the team and the advisor to the team will 'stick to' and understand the goal.

*Notes & Commentary*

# Basic Team Rules

- Team must develop their own ground rules
  - △ Once developed, everyone must live by them
  - △ Ground Rules are an aid to “self-management”
  - △ Team can modify or enhance the rules as they continue to meet
- Determine **if** there should be a meeting
- Decide **who** should attend
- Provide **advance** notices
- Maintain meeting **minutes** or records
- Establish **ground** rules
- Provide and Follow an **agenda**
- Evaluate meetings
- Allow **NO** interruptions

*Notes & Commentary*



## Team Meeting Responsibility

- Clarify
- Participate
- Listen
- Summarize
- Stay on track
- Manage time
- Test for consensus
- Evaluate meeting process

*Notes & Commentary*

# Team-to-Team Communication

- **Manage** by using a **Team Captain** or **Champion**
- Understanding of '**How We Work As A Team**'
- Should have a **Focus Person & Distributed Minutes**
- **Customer** teams
- **Internal** teams
- **Supplier** teams
- **Sub-Teams**
- **Subcontractors** should be encouraged to **embrace** **ISO 9001** or **APQP** and **QS 9000**



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*Notes & Commentary*

## Successful Teams

- Are management directed and focused
- Build their own identity
- Are accountable and use measurements
- Have corporate champions
- Fit into the organization
- Are cross-functional

Some Teams just “Do Not Work”

*Notes & Commentary*

# Team Check List

Team Check List	Yes	No
Has a champion accepted responsibility for monitoring the measurables?		
Have measurables been developed to the extent possible?		
Have special gaps been identified? Has the common cause versus special cause relationship been identified?		
Has the team leader been identified?		
Does the team leader represent the necessary cross-functional expertise?		
Has team information been communicated internally and externally?		
Has the team agreed upon the goals, objectives, and process for this problem solving effort?		
Is a facilitator needed to help keep process on track and gain consensus?		
Does the team have regular meetings?		
Does the team keep minutes and assignments in an action plan?		
Does the team work well together in following the process and objectives?		

## Notes & Commentary

Personally, I am a big fan of check lists. Every time you fly on an aeroplane, you should be thankful for check lists.

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## D2

### Describe The Problem

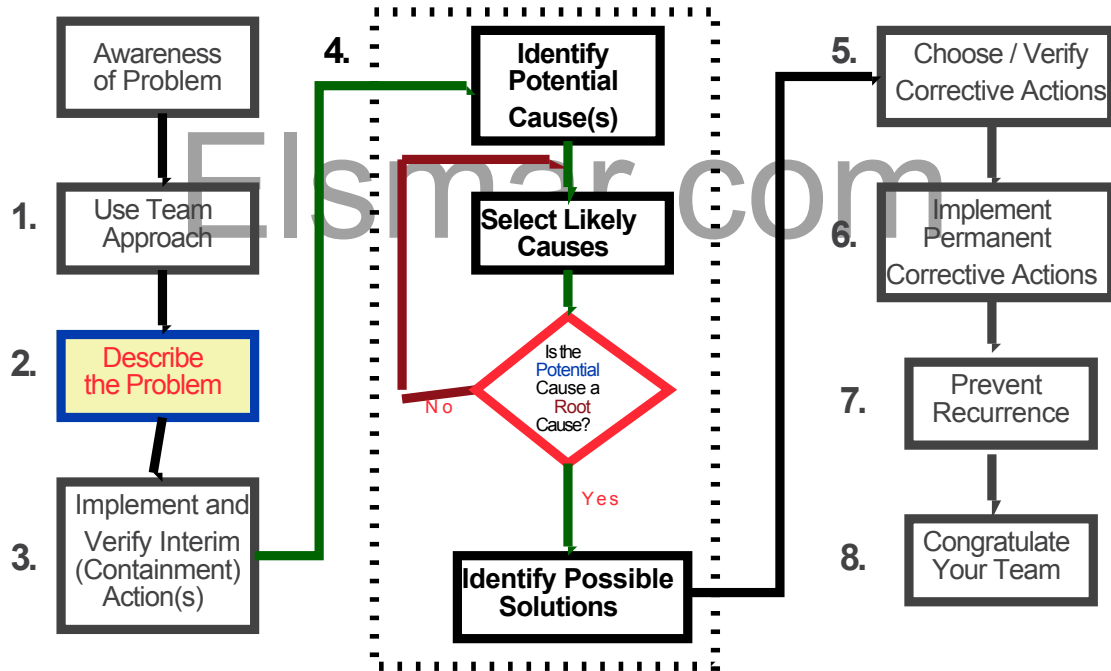
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*Notes & Commentary*

# The 8-D System



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*Notes & Commentary*

# Describe the Problem

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Specify the internal / external customer problem by identifying in **quantifiable** terms the **Who, What, When, Where, Why, How, How Many (5W2H)** for the problem.

*Notes & Commentary*

# Describe the Problem

- Problem definition is the basis of problem solving. The definition is used during brainstorming sessions to identify potential causes. Potential causes are those most likely causes that appear on the surface to be the source of the problem. A potential cause may be the root cause but must be supported by evidence.
- Part of the problem solving process is to identify the root cause of the problem and understand why it existed in the first place. Only then can a permanent solution be chosen and implemented. to make certain the problem will never surface again. The root cause is the reason the problem exists. When it is corrected or removed from the system, the problem will disappear. It is important to improve our understanding of today's technology to make possible the planning required to achieve quality and productivity breakthroughs for tomorrow and into the future.

## Notes & Commentary

If you can't describe the problem, there is no problem.



# Customer Complaints

Many problems arise from **customer complaints**. An **internal** customer's complaint could involve one department complaining that they cannot use the output of another department. An external customer complaint could involve a customer complaining to a dealer that a transmission 'shifts funny'.

**Frequently the wrong problem is solved and the customer complaint is not addressed.** It is very important that the customer complaint be clearly understood. The only method to ensure this is to have **direct customer contact**.

For internal customers, it is advisable to have representatives from the complaining organization as part of the problem solving team. In many cases this approach is the only way a problem can truly be solved.

External customer complaints typically require direct interviews to understand why the customer is not satisfied. It is not unusual for a customer complaint to be misrepresented by a company reporting system that classifies problems in prearranged standard categories.

*Notes & Commentary*

# Operational Definition of the Problem

It is important that the problem be described in terms that have the same meaning to everyone. This is best achieved through an operational definition. An operational definition consists of verifiable criteria that have the same meaning to the production workers, manager, customer, engineer, buyer, technician, team members, etc., and are used for past, present and future comparisons and analysis.

Sometimes problems are mistakenly described in terms of symptoms:

- △ Machine is down due to electrical problem. No backup machine or alternative available.
- △ The scrap rate has increased from "X" date from 3% to 22%.
- △ Customer warranty claims on "X" engine component is 12%.
- △ Failure of durability tests of a transmission component at 50,000 miles will delay launch.

*Notes & Commentary*

# Symptoms vs. Causes

It is not uncommon for problems to be reported as symptoms.

More examples are: noise, won't work, no power, machine down, broken tool, head froze up, contaminated, rough surface, porosity, shortage of parts, rattles, quality problem, worn out, line stopped, not to specification, labour problem, management problem, too much variation, etc.

The problem solving team must use a systematic approach to define the real problem in as much detail as possible. A definition of the problem can best be developed using approaches that organize the facts to get a comparative analysis. These approaches do this by asking what 'is' against what 'is not'. Then they draw distinctions from this comparison, testing these against the problem definition and forming a statement or description of the problem which must be resolved.

*Notes & Commentary*

# Problem Solving

Systematic approaches to problem solving:

- △ Business as a System (Business as a Process)
- △ Analytical problem solving
- △ Process flow

Problem analysis methodologies:

- △ 5W2H
- △ Stratification
- △ Comparative analysis
- △ Similarity analysis

Key questions --> 5W's and 2H's:

- △ Who? What? Where? When? Why? How? How Many?

*Notes & Commentary*

# In-Depth Analysis

An in-depth analysis is required to clearly define a problem. There are many examples where the analysis for a complete problem definition results in the solution being identified. The analysis starts with preparation (or review of the existing) **process flow diagram** to define clearly the work process and alternative paths. Team preparation or review ensures that all individuals are familiar with the process. After the flow diagram is reviewed, there are three principle parts of the problem analysis we discussed earlier:

- △ 5W2H
- △ Stratification
- △ Comparative/Similarity Analysis

First, quantify the 5W2H elements. In various problem analysis situations the investigators or problem solving teams must **continually test** to determine where they are located in the circle of circumstances. If a decision is made, what are the alternatives?

*Notes & Commentary*

# 5W - 2H Analysis

It is sometimes difficult to define the problem and sort out real differences. The first, most important step, however, it to **determine that the customer complaint is fully understood.**

5W2H :

- △ **Who?** Identify customers complaining
- △ **What?** Identify the problem adequately and accurately
- △ **When?** Timing - When did the problem start?
- △ **Where?** Location - Where is it occurring?
- △ **Why?** Identify known explanations
- △ **How?** In what mode or situation did the problem occur?
- △ **How Many?** Magnitude - Quantify the problem

To reduce the risk of making wrong decisions, consideration and analysis of potential problems in advance will provide **contingency actions** to maintain control and protect the customer.

*Notes & Commentary*

# 5W - 2H Analysis

- 5**  
**W**
- △ **Who?** - Identity individuals associated with the problem. Characterize customers who are complaining. Which operators are having difficulty?
  - △ **What?** - Describe the problem adequately. Does the severity of the problem vary? Are operational definitions clear (e.g. defects)? Is the measurement system repeatable and accurate?
  - △ **When?** - Identify the time the problem started and its prevalence in earlier time periods. Do all production shifts experience the same frequency of the problem? What time of year does the problem occur?
  - △ **Where?** - If a defect occurs on a part, where is the defect located? A location check sheet may help. What is the geographic distribution of customer complaints?
  - △ **Why?** - Any known explanation(s) contributing to the problem should be stated.
- 
- 2**  
**H**
- △ **How?** - In what mode or situation did the problem occur? What procedures were used?
  - △ **How Many?** - What is the extent of the problem? Is the process in statistical control?

*Notes & Commentary*

# Stratification Analysis

**Stratification Analysis** determines the **extent of the problem** for relevant factors.

- △ Is the problem the same for all shifts?
- △ Do all machines, spindles, fixtures have the same problem?
- △ Do customers in various age groups or parts of the country have similar problems?

The important **stratification factors** will **vary with each problem**, but most problems will have several factors. Check sheets can be used to collect data. Essentially this analysis seeks to develop a pareto diagram for the important factors. The hope is that the extent of the problem will not be the same across all factors. The differences can then lead to identifying root cause.

When the **5W2H** and **Stratification Analysis** are performed, it is important to consider a number of indicators. For example, **a customer problem identified by warranty claims may also be reflected by various in-plant indicators.**

Sometimes, customer surveys may be able to define the problem more clearly. In some cases analysis of the problem can be expedited by correlating different problem indicators to identify the problem clearly.

## Notes & Commentary

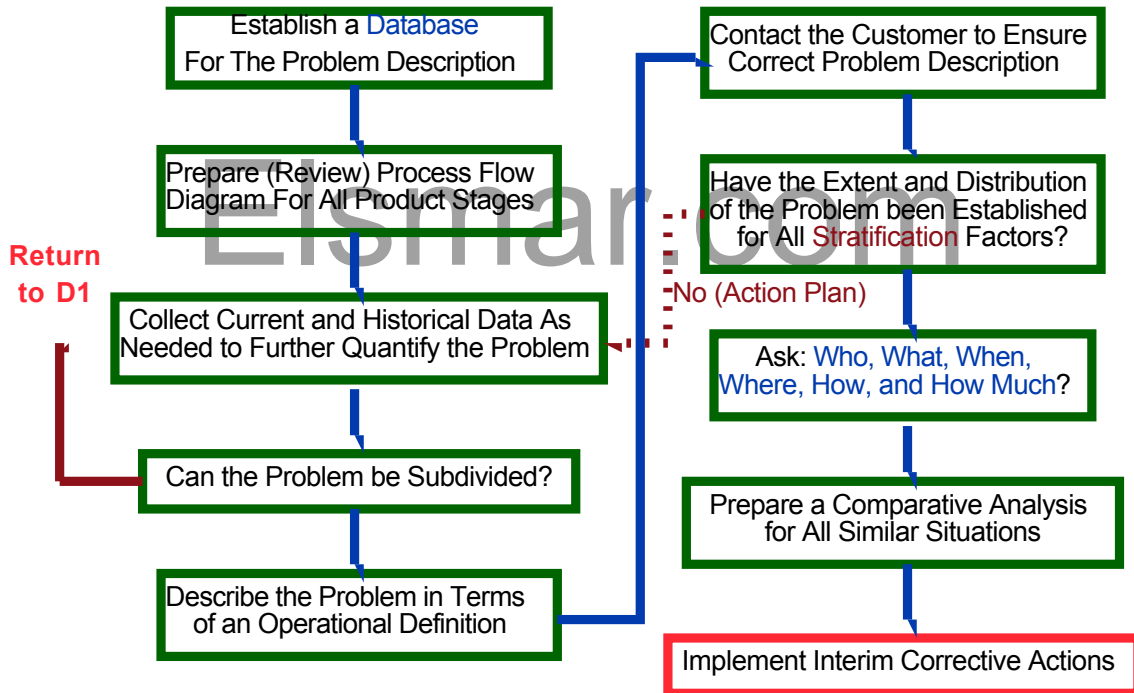


# Describe the Problem

- It has been said that there are no new problems, only different manifestations of old problems. In problem definition, it is often useful to quantify the problem in similar situations. The criteria to match similar situations will vary with the type of problem. Identifying effective matches and evaluating the presence of the problem provides useful information to generate potential causes and possible problem solutions. If the similarity analysis identifies a comparable situation where the problem does not exist, the analysis can focus on the differences in where the problem is occurring and where it is not occurring.
- Once the 3 types of analysis have been completed, it is sometimes possible to divide the problem into separate problems. It is easier to address these smaller problems because fewer root causes are involved. In the ideal case, a single root cause would be responsible for each problem. If the problem is separated, different teams may be required to address each problem.
- All three elements of the problem definition are not used for every problem. However, collectively the different analyses provide a comprehensible description. You are developing a specification of the problem.

Notes & Commentary

# Describe the Problem Flow



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*Notes & Commentary*

# Root Cause Analysis

**Symptom**

A Drop In Average Weekly Hours  
Worked By Third Shift Employees

WHY?

The Employees Are Arriving Late

WHY?

**Initial  
Problem  
Descriptions**

Traffic Jam  
On I-29

Buses  
Late

Not  
Enough  
Parking

Bad Weather

Road  
Construction

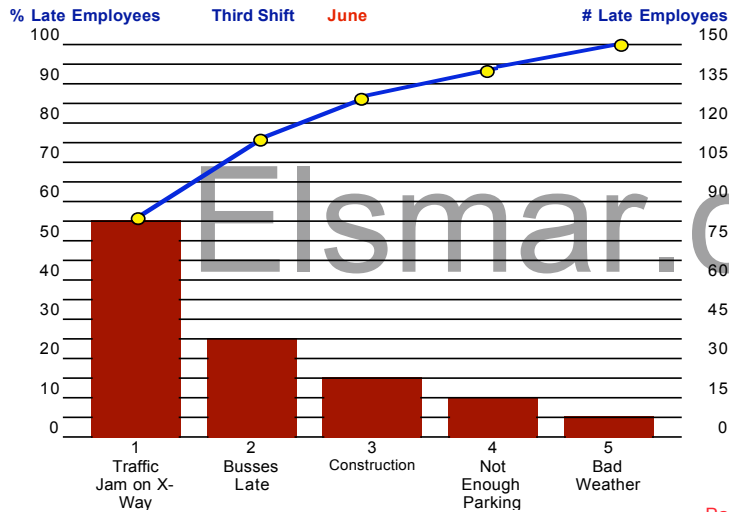
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*Notes & Commentary*

# Investigative / Tracking Charts



Pareto - Used To Assess The 'WHY's and for Tracking

Paynter Chart - Used To Track Progress

Incidents

Problems:	July	Aug	Sept	Oct	Nov	Dec	Total
Traffic jam on Hiway	90						90
Busses Late	30						30
Not Enough Parking	17						17
Bad Weather	9						9
Road Construction	4						4
	150						150

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## Notes & Commentary

# Is / Is Not Questions

Is

Is Not

What:	What is the object you are having a problem with?	What could be happening but is not?
	What is the problem concern?	What could be the problem concern, but is not?
Where:	Where do you see the concern on the object? Be specific in terms of inside to outside, end to end, etc.	Where on the object is the problem NOT seen? Does the problem cover the entire object?
	Where (geographically) can you take me to show me the problem? Where did you first see it?	Where else could you have observed the defective object, but did not?
When:	When in time did you first notice the problem? Be as specific as you can about the day and time.	When in time could it have first been observed, but was not?
	At what step in the process, life or operating cycle do you first see the problem?	Where else in the process, life or operating cycle might you have observed the problem, but did not?
	Since you first saw it, what have you seen? Be specific about minutes, hours, days, months. Can you plot trends?	What other times could you have observed it but did not?
How Big:	How much of each object has the defect?	How many objects could be defective, but aren't?
	What is the trend? Has it leveled off? Has it gone away? Is it getting worse?	What other trends could have been observed, but were not?
	How many objects have the defect?	How many objects could have had the defect, but didn't?
	How many defects do you see on each object?	How many defects per object could be there, but are not?
	How big is the defect in terms of people, time, \$ and/or other resources?	How big could the defect be, but is not?
	What percent is the defect in relation to the problem?	

NOTE: Every Question May Not Apply!

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*Notes & Commentary*

# Is / Is Not Example

	Is	Is Not
<b>What:</b>		
Object	Heavy traffic	
Defect	Late Employees	
<b>Where:</b>		
Seen on object	I-70 Expressway	
Seen geographically	East bound I-70 near Main Street	
<b>When:</b>		
First seen	July 7, 1996	
When else seen	Ever since	
When seen in process (life cycle)	Afternoon	
<b>How Big:</b>		
How many objects have the defect?	Third shift (4:00PM)	
How many defects per object?	Once per day	
What is the trend?	Increasing --> SPECIAL CAUSE!	
Enhanced Problem Description -->		

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*Notes & Commentary*

# Timing Plan

Depends upon

- Product **complexity**
- Customer **expectations**

Team plan for

- Training
- Event
- Action



Do NOT Under Estimate the  
Importance of **Timing!**

Framework for **tracking**

Basis for **status reporting**

Prepare a **timing chart** using available project or similar software

*Notes & Commentary*

# Describe the Problem Phases

## Phase I

- State the symptom, extent and consequence of the problem.
- Prepare / Review process flow diagram.
- Start an Action Plan to define the problem. Identify Who will do What by When.

## Phase II

- Identify Who, What, Where, When, Why, How and How Much.
- Qualify the extent of the problem to help identify relevant stratification factors.
- Evaluate similar situations where the problem might be expected to occur.
- Use all available indicators. Be creative about these.
- Subdivide the problem into natural problem groups.

*Notes & Commentary*



# Describe the Problem Questions

## Questions

### What Type of Problem Is It?

- Field complaint
- Quality improvement
- Manufacturing improvement
- Component design
- Labour / Personnel
- Supplier / Vendor
- Cost improvement
- Solution implementation
- Cross functional
- Research
- Safety

## Other Questions

- Can you list all of the resources and documents which might help you specify the problem more exactly?
- Do you have more than 1 problem? Can this situation be separated into smaller parts?

## Is / Is Not

- Is there any evidence this problem surfaced before?

*Notes & Commentary*

## Describe the Problem - 5W-2H

### Who, What, When, Where, Why, How, How Many

- † What is the extent of the problem?
- † Has the problem been increasing, decreasing or remaining constant?
- † Is the process stable?
- † What indicators are available to quantify the problem?
- † Can you determine the severity of the problem? Can you determine the various 'costs' of the problem? Can you express the cost in percentages, dollars, pieces, etc.?
- † Do we have the physical evidence on the problem in hand?
- † Have all sources of problem indicators been identified and are they being utilized?
- † Have failed parts been analyzed in detail?

*Notes & Commentary*

# Customer Terms / Symptoms

- △ Who is the customer?
- △ Is there more than 1 customer? If so, which customer first identified the problem?
- △ To whom was the problem reported in the customer's organization?
- △ What is the problem definition in customer terms?
- △ What is the problem definition in YOUR terms?
- △ Have we verified the problem with on-site visits with the customer?

*Notes & Commentary*

# Understanding Your Processes and Systems

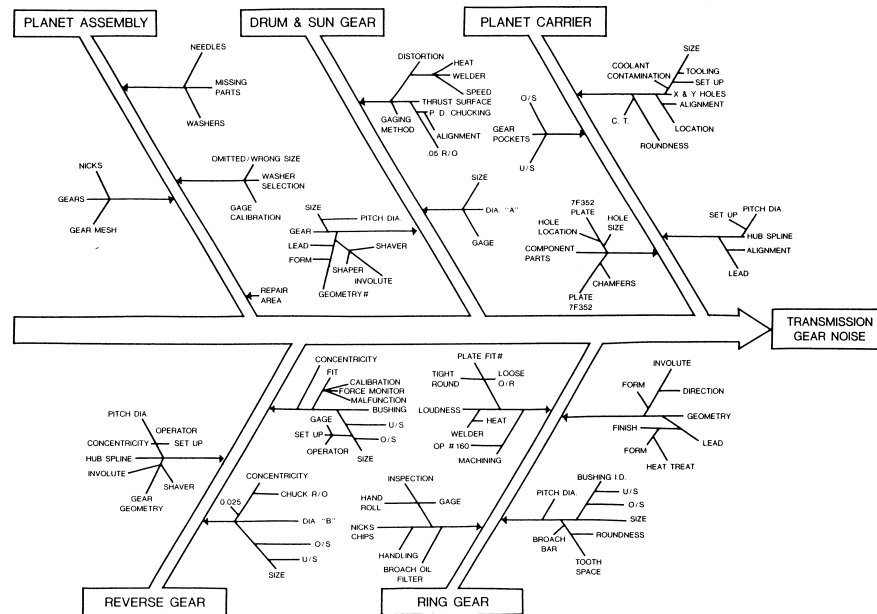
## Use a Process Flow Chart!

### Because:

- You want to understand your current process.
- You are looking for opportunities to improve.
- You want to illustrate a potential solution.
- You have improved a process and want to document the new process.

*Notes & Commentary*

# Production Cause and Effects Diagram



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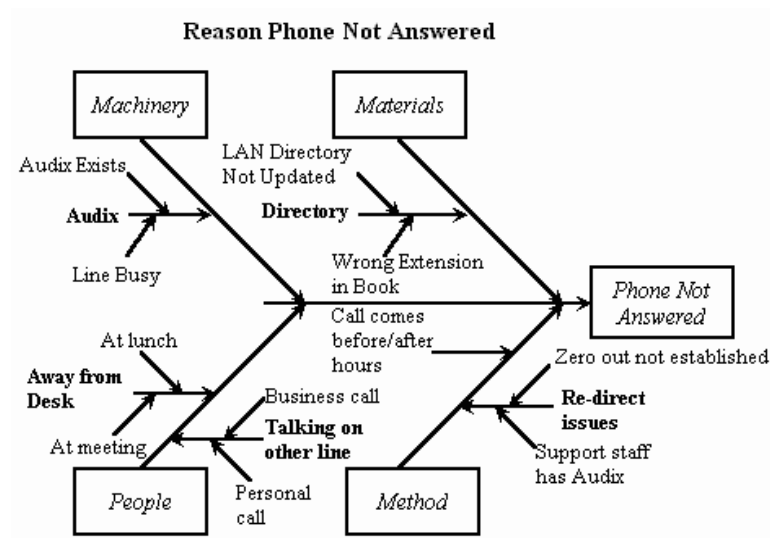
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## Notes & Commentary

This is an example of a somewhat detailed cause and effect diagram.

# Service Cause and Effects Diagram

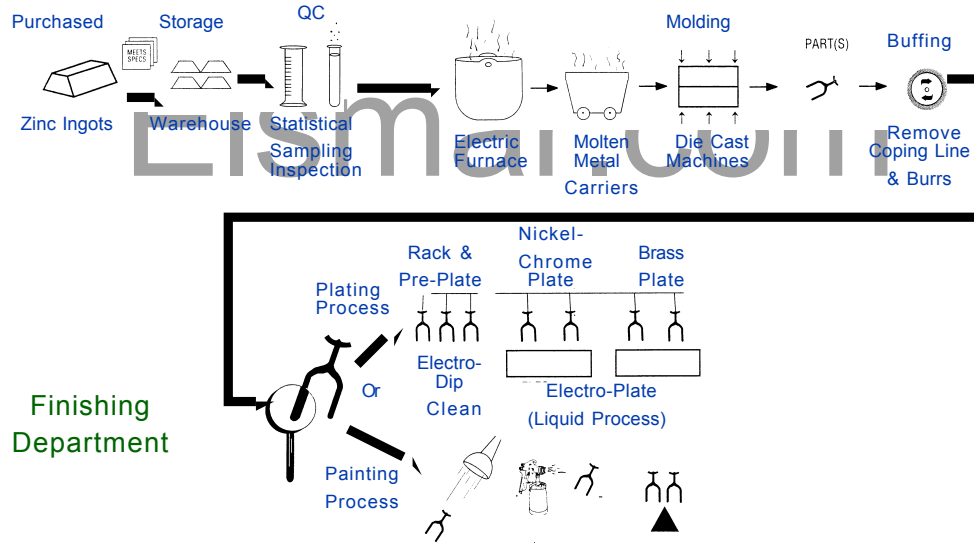


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Also see: <http://lorien.ncl.ac.uk/ming/spc/spc6.htm>

# Flow Charting

## Die Cast Production



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# Notes & Commentary

# Creating a Process Flow Chart

1. **Identify the process or task** you want to analyze. Defining the scope of the process is important because it will keep the improvement effort from becoming unmanageable.
2. **Ask the people** most familiar with the process to help construct the chart.
3. **Agree on the starting point and ending point.** Defining the scope of the process to be charted is very important, otherwise the task can become unwieldy.
4. **Agree on the level of detail** you will use. It's better to start out with less detail, increasing the detail only as needed to accomplish your purpose.

*Notes & Commentary*



# Creating a Process Flow Chart

## 5. Look for areas for improvement

- Is the process standardized, or are the people doing the work in different ways?
- Are steps repeated or out of sequence?
- Are there steps that do not add value to the output?
- Are there steps where errors occur frequently?
- Are there rework loops?

## 6. Identify the sequence and the steps taken to carry out the process.

## 7. Construct the process flow chart either from left to right or from top to bottom, using the standard symbols and connecting the steps with arrows.

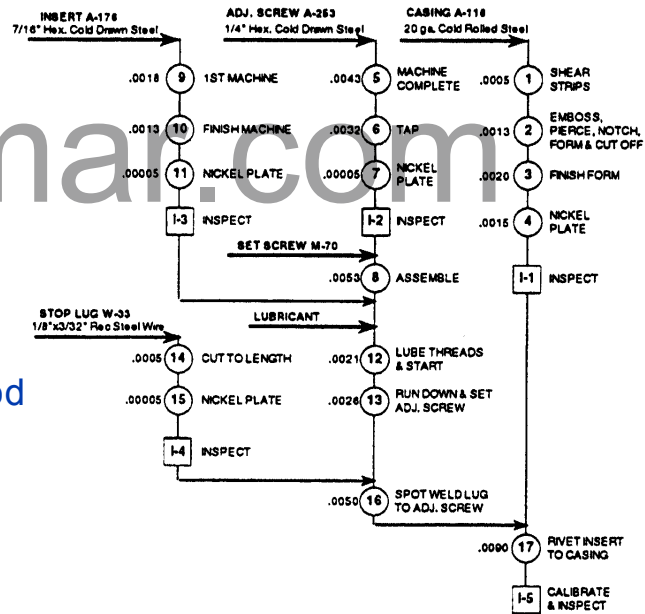
## 8. Analyze the results.

- Where are the **rework loops**?
- Are there process steps that don't add value to the output?
- Where are the differences between the current and the desired situation?

*Notes & Commentary*

# Early Process Flow Diagram

- Inspection Points
- Inspection Frequency
- Instrument
- Measurement Scale
- Sample Preparation
- Inspection/Test Method
- Inspector
- Method of Analysis



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*Notes & Commentary*

# GM Example Process Flow Chart

Process Flow Diagram						Approved By:			
Part Number: _____			Date: 4/5/93			QA Manager _____			
Part Description: _____			Rev. : C			Operations Manager _____			
Prepared By: _____						Senior Advisor _____			
						QA Engineer _____			
Step	Fabrication	Move	Store	Inspect	Operation Description	Item #	Key Product Characteristic	Item #	Key Control Characteristic
1		○			Move "OK" Vinyl Material From Storage Area and Load Into Press.	1.0	Material Specs	1.0	Material Certification Tag
2	◇				Auto Injection Mold Cover In Tool #	2.0	Tearstrip In Cover	2.1 2.2	Tool Setup Machine Setup
						3.0	Hole Diameter In Cover	2.1 2.2	Tool Setup Machine Setup
						4.0	Flange Thickness In Cover	2.1 2.2	Tool Setup Machine Setup
						5.0	Pressure Control Protrusions Height	2.1 2.2	Tool Setup Machine Setup
3				□	Visually Inspect Cover	6.0	Pressure Control Protrusions Filled Out	2.1 2.2	Tool Setup Machine Setup

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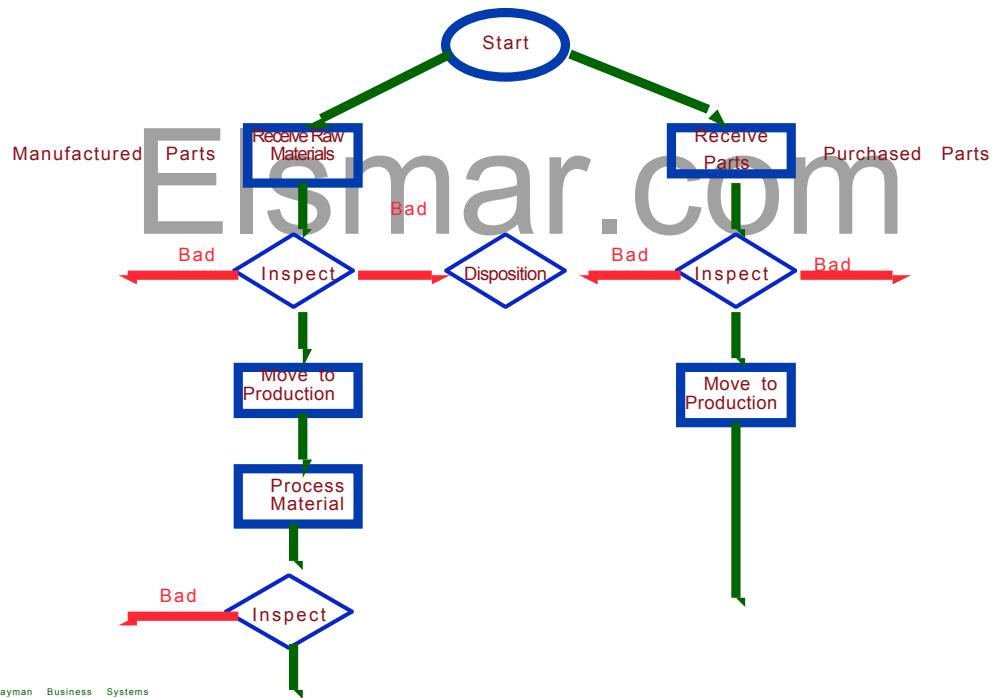
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Notes & Commentary

## Basic Flow Chart Example



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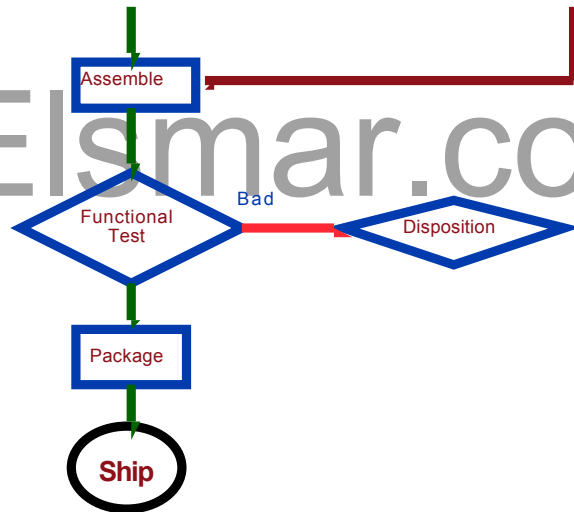
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# Notes & Commentary

# Basic Flow Chart Example



*Notes & Commentary*

# Control Plan Example (GM)

Process Control Plan																	
Supplier Name: _____				Supplier Code: _____				Part Number: _____				Part Description: _____					
Title: _____				Date: 4/5/93				Engineering Change Letter: _____				Process Plan Effective Date: 4/5/93					
Key Product Control Characteristics				Gage Study				Process Capability (Short Term Capability)				Process Performance (Long Term Capability)				Controls	
[1] Item	[2] Key Product Characteristic/Spec	[3] Key Control Characteristics	[4] Operation Description	[5] Gage Operation	[6] Attr./Variable	[7] Last R&R Date	[8] % Gage R&R	[9] Process Capability Date	[10] % Process Capability	[11] Cpk or Dev From Target/Nom.	[12] Process % Perform. Date	[13] Process % Perform. Date	[14] Process Cpk or Dev From Target/Nom.	[15] Type Of Control Method	[16] Freq. Of Inspect.	[17] Operator Set-Up Gage Instruction (Proced. #)	[18] Process Audit Method and Frequency
1.0	Vinyl Material Spec													Check Vendor Cert(s).	Every Box		Green "OK" Release, Each Box
2.0	Tear Strip (Cover) 1 = 0.41mm +/- 0.11mm  2-7 = 0.685mm +/- 0.135mm [7]		Auto Injection Mold Cover In TL#						[1] [2] [3] [4] [5] [6] [7]	[1] [2] [3] [4] [5] [6] [7]				X bar and R Charts  SQC Database	Start Of Each Run And Each Shift	3.607	
2.1														Verify To Spec Sheet			
2.2		Tool Setup Machine Setup															
3.0	Hole Diameter (Cover) 4.60mm +/- 0.25mm		Auto Injection Mold Cover TL#						[1] [2] [3] [4] [5] [6]	[1] [2] [3] [4] [5] [6]				X bar and R Charts  SQC Database	5 Pieces Every 6 Months	3.609	

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This form is on course disk Slide 110

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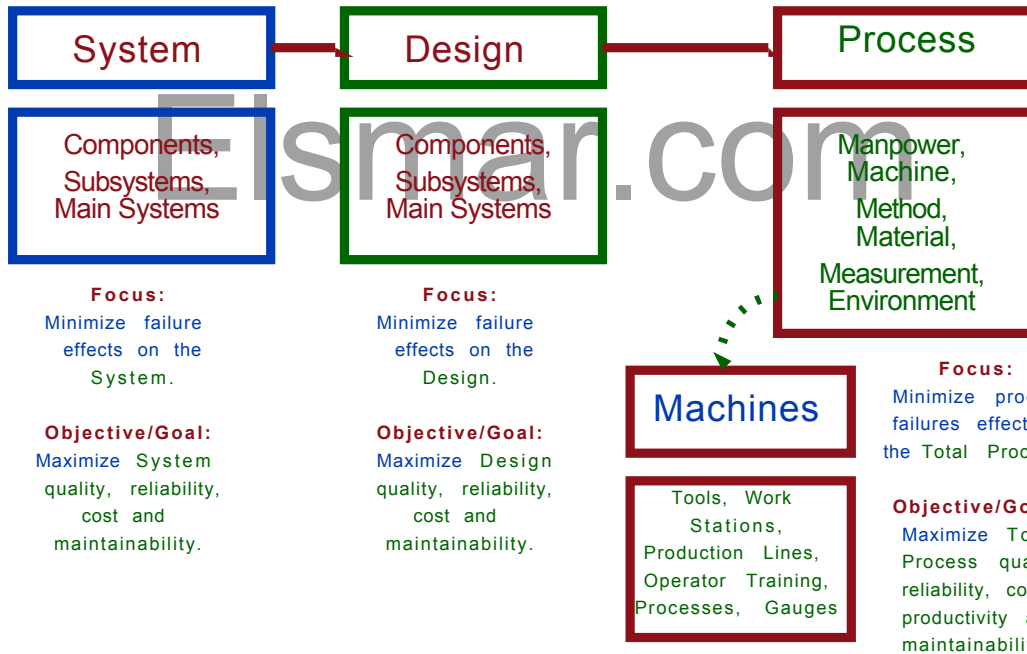
*Notes & Commentary*

# FMEAs - Predicting Failure & Problems

How It Works

What Its Made Of

How Its Made



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*Notes & Commentary*

# Describe The Problem Check List

## Problem Check List

Yes No

Based upon the pareto chart, has the problem description been established using repeated WHYs??		
Have all Is / Is-Not and What-Where-When&How Big questions been answered?		
Have all sources of problem indicators been used?		
Have failed parts been analyzed and the problem verified?		
Does the problem description contain the object, concern, quantification and has it been included on the Paynter chart?		

*Notes & Commentary*



# D3 Containment

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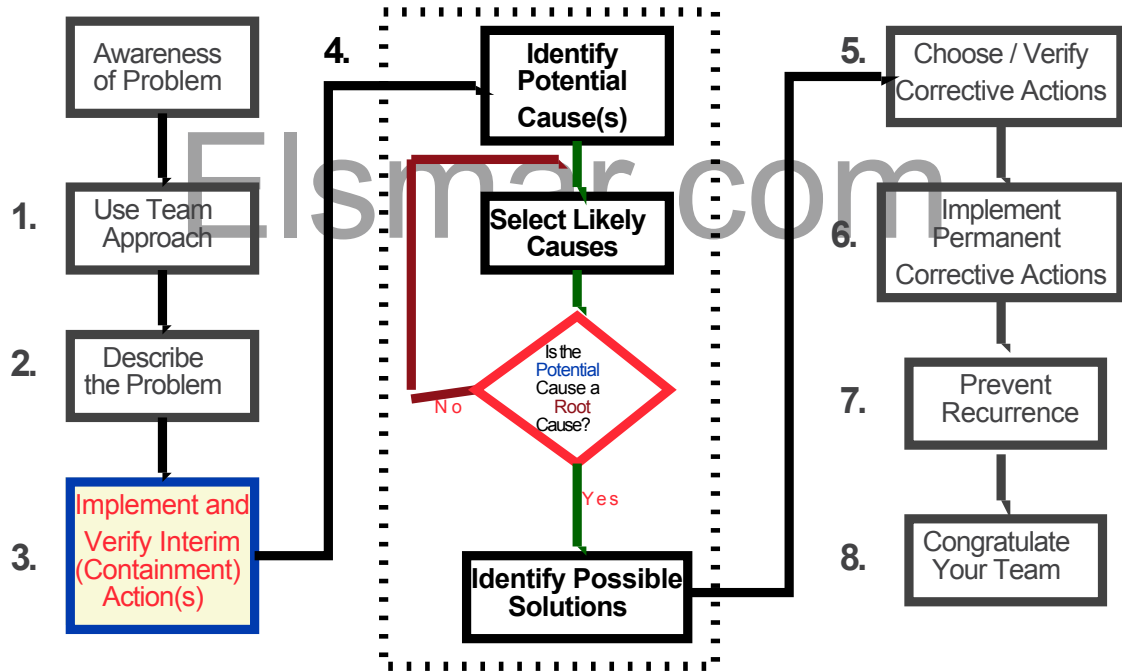
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*Notes & Commentary*

# The 8-D System



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*Notes & Commentary*

## Implement and Verify Interim (Containment) Actions

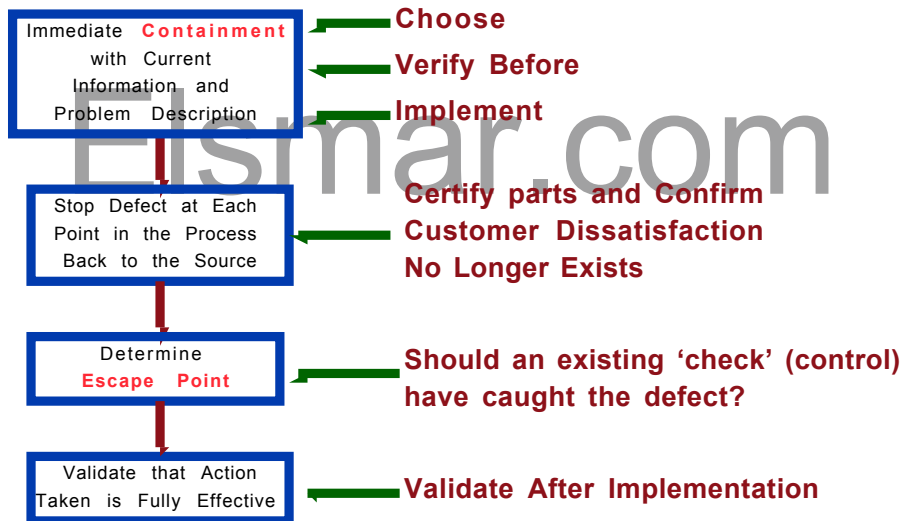
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Define and Implement containment actions to **isolate the effect** of the problem from any internal / external customer until corrective action is implemented.

**Verify the effectiveness** of the containment action.

*Notes & Commentary*

# Contain Symptom Flow



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## Notes & Commentary

What you do to ensure that product shipped from the point at which you know of the problem is 'Conforming' [HOLD EVERYTHING!!!! - What have we got here?] (often 100% inspection/test for the specific defect and then you 'certify' [as per the SS requirement, but typical outside the sector as well - can you say SORT?] each shipment for an agreed upon time period - which depends upon the problem identified, etc., as I'm sure you know). This is what you ship to the customer within X hours (not always considering reality). The intent here with the stated hours is to avoid interrupting a customer's manufacturing schedule.

Identify part number and determine what has been shipped, when, what is in the hands of customers (in their stock - requires close contact with a customer 'point of contact'), what is enroute, etc.

Determine when the 'event' occurred (like lot number).

Isolate in-house and warehoused suspect product.

Determine earliest and latest. Start wide and narrow down as you go. Eg. Did test fail? When? Is this a 'standard' that went bad? In the case of a test instrument calibration, when was the last calibration? Can you test interim product to see if stuff in between is OK or where the calibration went far enough out as to allow nonconforming product to be 'passed' and shipped. What shipped product lots are 'suspect' and 'what's in the pipeline'?

Close communication with customers to ensure 'timely' update on possible (suspect) lots or known 'contaminated' lots.

The customer has to have knowledge of lots - what may they have shipped that was assembled with your suspect component.

# Containment Actions Objective

Define and Implement containment actions to isolate the effect of the problem from internal and external customers until corrective action is implemented.

Verify the **effectiveness** of the containment action(s).

*Notes & Commentary*

## Containment Actions

The main objective of this part of the problem solving process is to isolate the effects of the problem by implementing containment actions. A problem may be poor quality, marginal product design, or a process or system that is unpredictable. A containment action may be stopping production of a known source of a problem, or not shipping any parts or assemblies until the source of the problem is identified.

Once a problem has been described, immediate actions are to be taken to isolate the problem from the customer. In many cases the customer must be notified of the problem. These actions are typically 'Band-aid' fixes. Common containment actions include:

- † 100% sorting of components
- † Cars inspected before shipment
- † Parts purchased from a supplier rather than manufactured in-house
- † Tooling changed more frequently
- † Single source

*Notes & Commentary*

## Containment Actions

Unfortunately, most containment actions will add significant cost (\$)

to the product. However, it is important to protect the customer from the problem until permanent corrective actions can be verified and implemented.

Most interim actions are 'temporary short term' actions taken until a permanent corrective action is defined, implemented and verified. The danger of many interim corrective actions is that they are considered to be a permanent solution to the problem. It must be remembered that they are typically 'band-aids'. It is a mistake to view containment actions as a solution to the problem. Containment actions typically address the effect. They should be considered 'immediate first-aid' to be reviewed and removed as quickly as possible.

*Notes & Commentary*

## Containment Actions

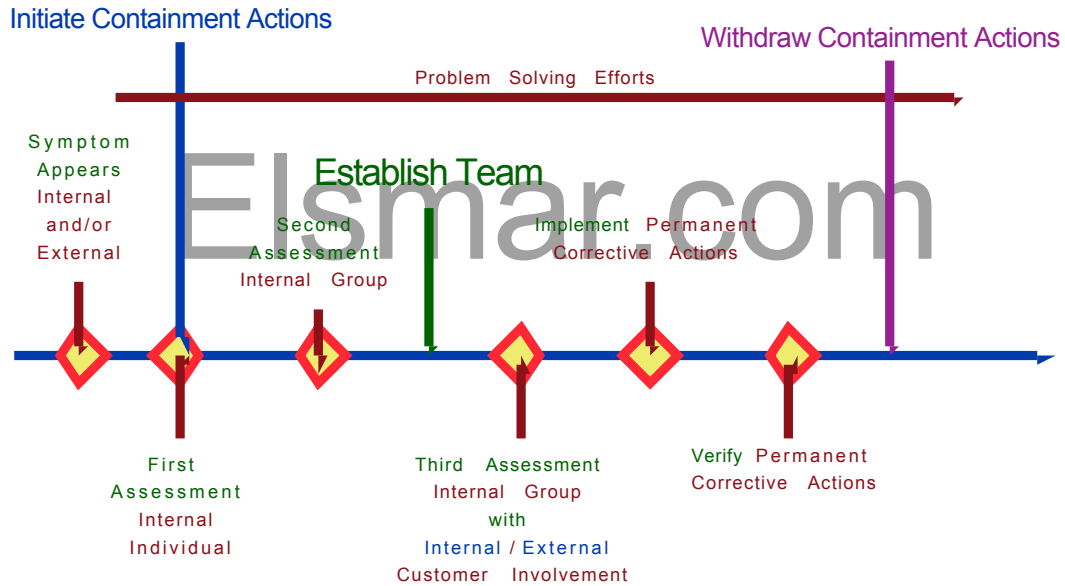
Containment actions can and often should **proceed in parallel** with the **root cause determination investigation**. During the period in which containment actions are taking place, many useful things must be pursued as a first step in finding the root cause. These things include:

- † Establishing an **investigative plan**
- † Obtaining **baseline data**
- † Initiating an **on-going control system**
- † Developing a **follow-up and communications system**
- † Correcting products already produced
- † Start **systematic investigations**
- † Conduct special studies and statistical experiments
- † **Understand the problem**      Review experiences and data with current trends
- † **Forecast the future**

*Notes & Commentary*



# Typical 8-D Time Line



This process can stop or loop back upon its self at any point in the process.

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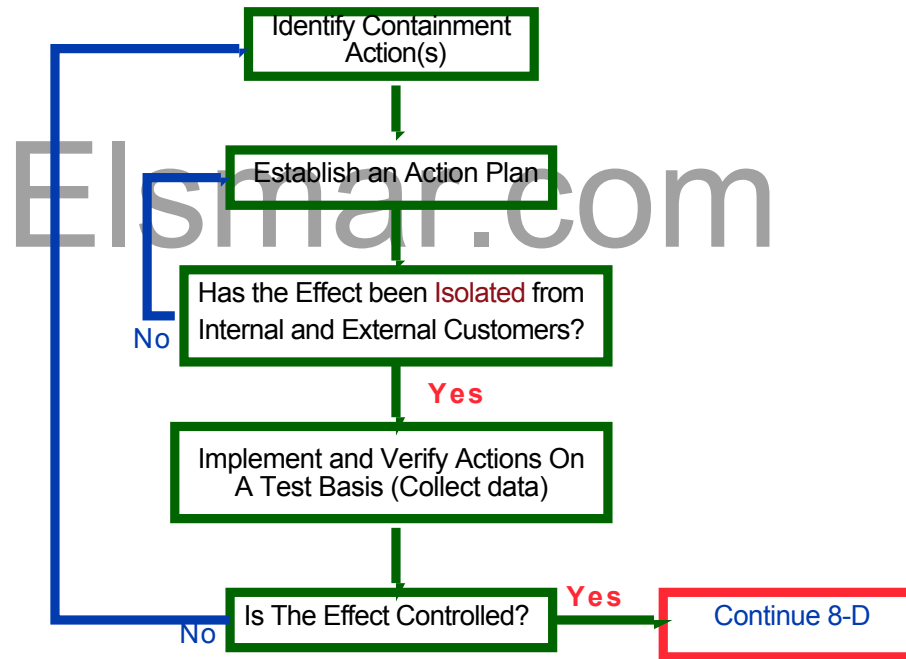
*Notes & Commentary*

## Containment Actions

- A design test on data collection (i.e. check sheets, control charts, etc.) can be used to evaluate the effectiveness of the actions. The process can be monitored using control charts and histograms. An action plan should define who, what and when clearly to coordinate the interim fixes.
- Individuals should be encouraged to gain knowledge about the entire process. Ask - What would be the effect of:
  - † Incorporating robust engineering designs
  - † Establishing manufacturing feasibility
  - † Determining how one operation or dimension affects another
  - † Centering the process
  - † Over adjusting and / or under adjusting a machine or process
  - † Improving machine set-up
  - † Changing tools
  - † Improving maintenance, etc.
- Well engineered management systems, practices and procedures need to be coupled with effective training programs. Together these can provide the best protection to prevent recurrence of the problem by new technologies, new methods, new employees, job rotation or improvement of individual skills.

*Notes & Commentary*

## Containment Actions Flow



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*Notes & Commentary*

## Verifying Containment Actions - Pilot Runs

### Run Pilot Tests

- Artificially simulate the solution to allow actual process or field variation.
- Field test the solution using pilot customer groups.
- Verify carefully that another problem is not generated by the solution.

### Monitor Results

- Quantify changes in key indicators.
- Stress the customer / user evaluation.

*Notes & Commentary*

## Containment Actions Verification Questions

- Have all alternatives been evaluated?
- Are responsibilities clear and defined?
- Is the required support available?
- When will the actions be completed?
- Have you ensured that implementation of the interim solution will not create other problems?
- Will all interim actions last until long-range actions can be implemented?
- Is the action plan coordinated with customers?
- Have tests been done to evaluate the effectiveness of the interim actions?
- Is data being collected to ensure actions remain effective?

*Notes & Commentary*

# Contain Symptom Check List

## Contain Symptom Check List

Yes

No

Has immediate containment action been taken to protect the customer?		
Has the concern been stopped at each point in the process back to the source?		
Have you verified that the action taken is FULLY effective?		
Have you certified that parts no longer have the symptom?		
Have you specially identified the 'certified' parts?		
Have you validated the containment action?		
Is data being collected in a form that will validate the effectiveness of the containment action?		
Has baseline data been collected for comparison?		
Are responsibilities clear for all actions?		
Have you ensured that implementation of the containment action will not create other problems?		
Have you coordinated the action plan with the customer?		

*Notes & Commentary*

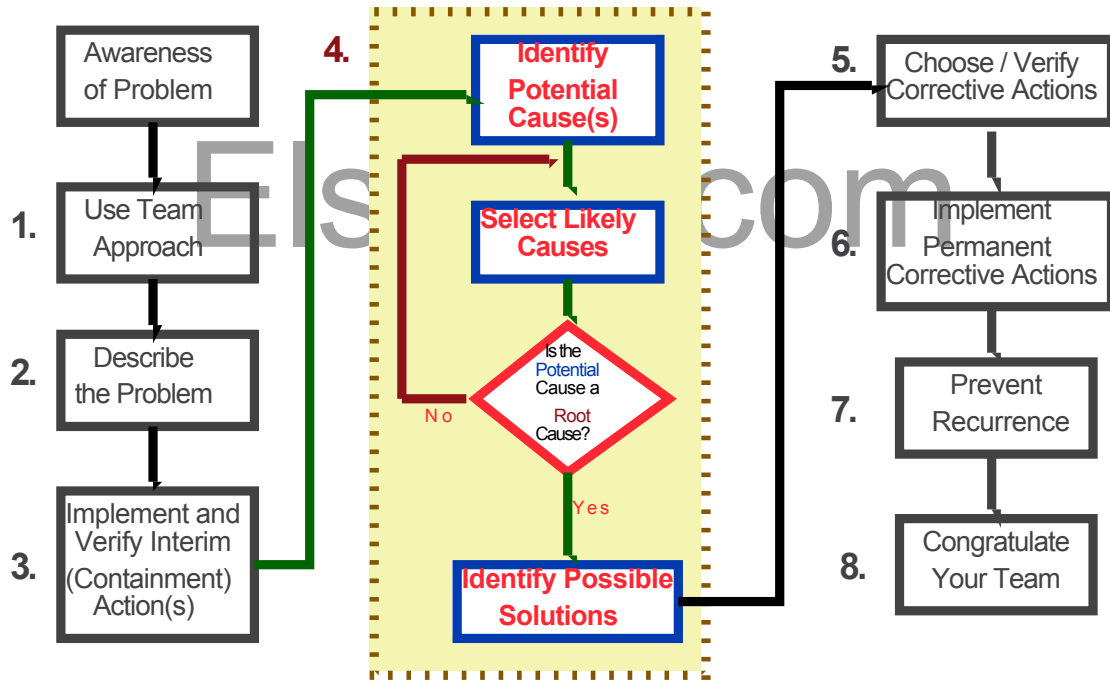
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## D4

### Define Root Cause(s)

## Notes & Commentary

# The 8-D System



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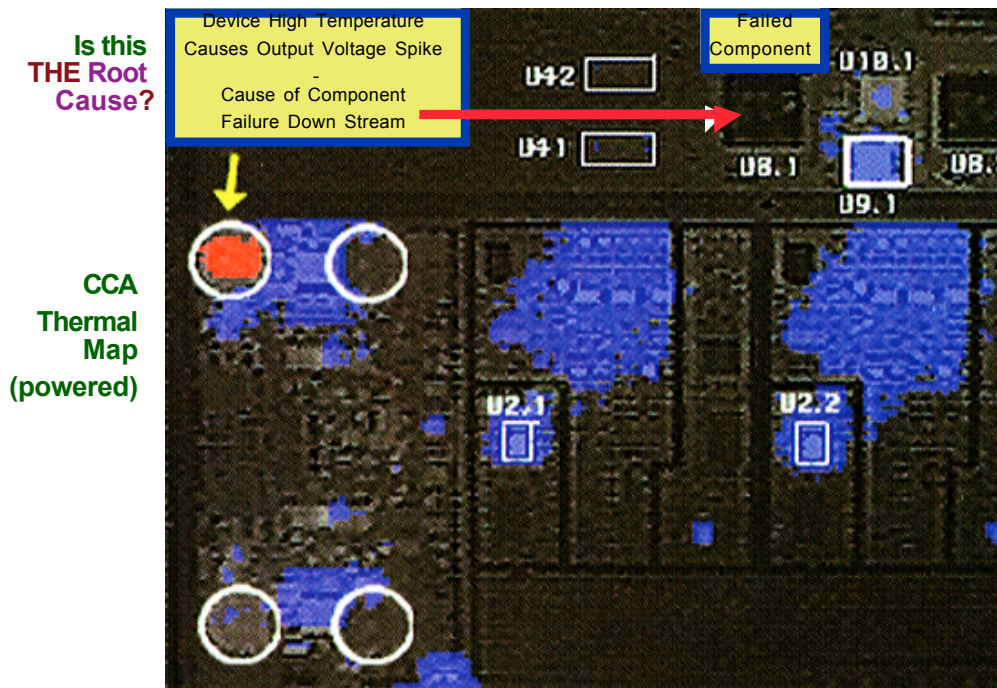


# Define and Verify Root Cause(s)

- **Identify all potential causes** which could explain why the problem occurred.
- **Isolate and verify the root cause by testing** each potential cause against the problem description and test data. Identify alternate corrective actions to eliminate root cause.

*Notes & Commentary*

# Root Cause Of A Failure



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*Notes & Commentary*

## Two Root Causes

### Root Cause of **Event** (Occur or Occurrence)

What **system** allowed for the event to **occur**?

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### Root Cause of **Escape**

What **system** allowed for the event to **escape** without detection?

*Notes & Commentary*

# Initial Data Evaluation

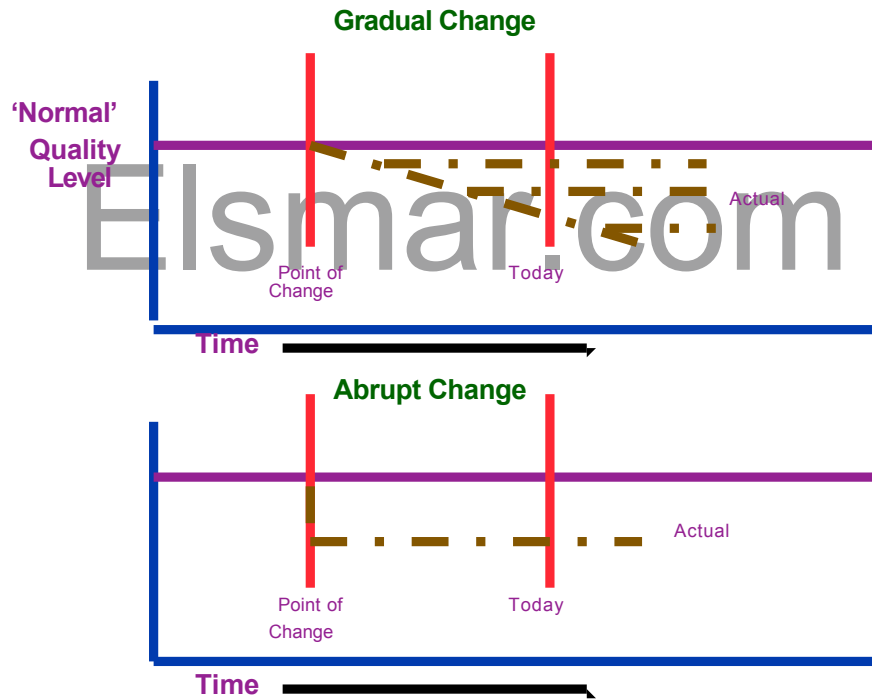
Change Induced vs. Unidentified (New)

Gradual vs. Abrupt vs. Periodic

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*Notes & Commentary*

# Initial Data Evaluation



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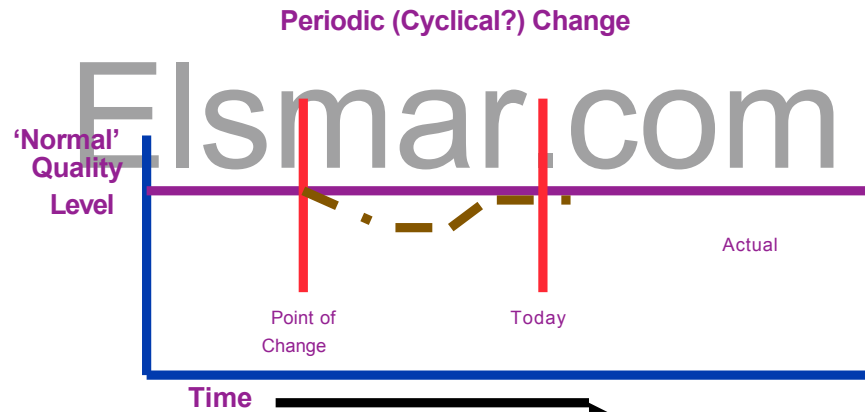
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# Initial Data Evaluation



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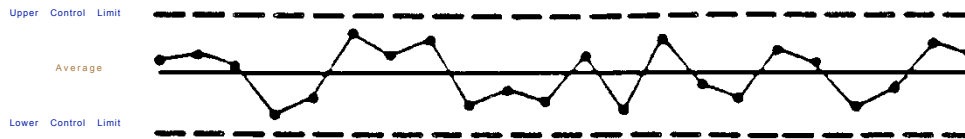
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*Notes & Commentary*

# Interpreting Control Charts

Control Charts provide information as to whether a process is being influenced by **Chance** causes or **Special** causes. **A process is said to be in Statistical Control when all Special causes of variation have been removed and only Common causes remain.** This is evidenced on a Control Chart by the **absence of points beyond the Control Limits** and by the **absence of Non-Random Patterns or Trends** within the **Control Limits**. A process in Statistical Control indicates that production is representative of the best the process can achieve with the materials, tools and equipment provided. Further process improvement can only be made by reducing variation due to **Common** causes, which generally means management taking action to improve the system.



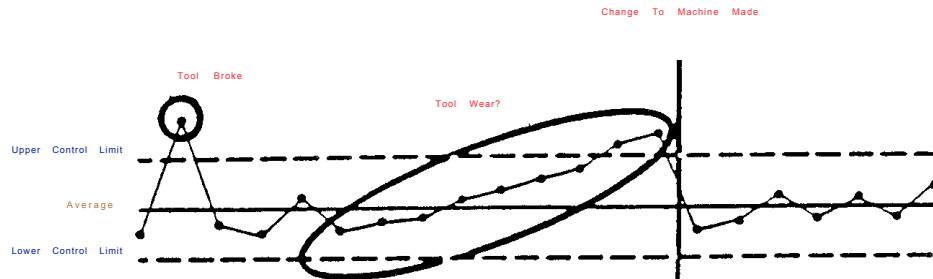
- A. Most points are near the center line.
- B. A few points are near the control limit.
- C. No points (or only a 'rare' point) are beyond the Control Limits.

*Notes & Commentary*

# Interpreting Control Charts

When Special causes of variation are affecting a process and making it unstable and unreliable, the process is said to be Out Of Control. Special causes of variation can be identified and eliminated thus improving the capability of the process and quality of the product. Generally, Special causes can be eliminated by action from someone directly connected with the process.

The following are some of the more common Out Of Control patterns:

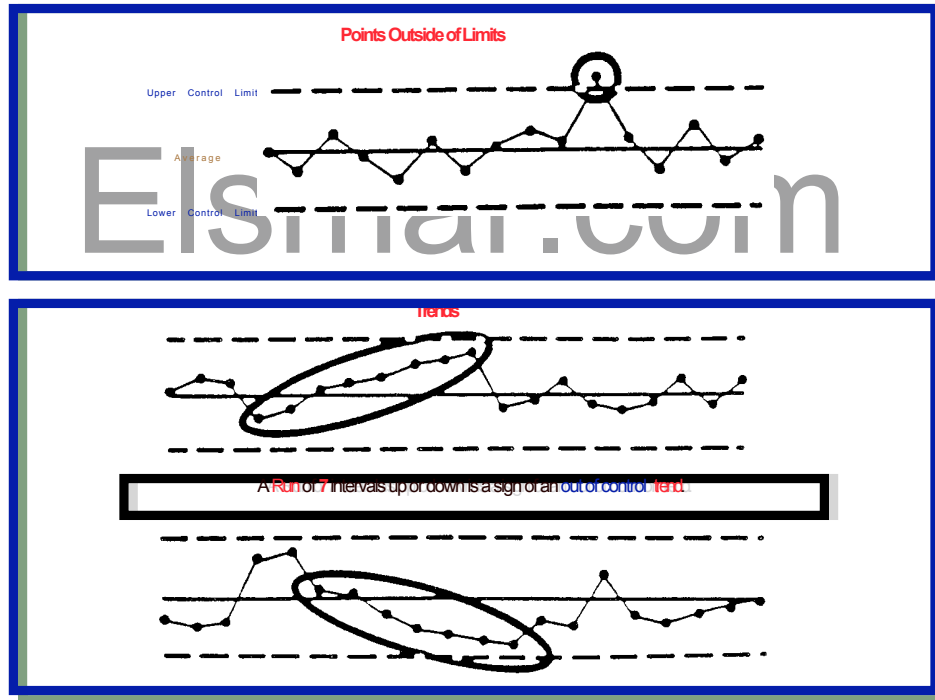


A. Most points are near the center line.

Notes & Commentary



# Interpreting Control Charts



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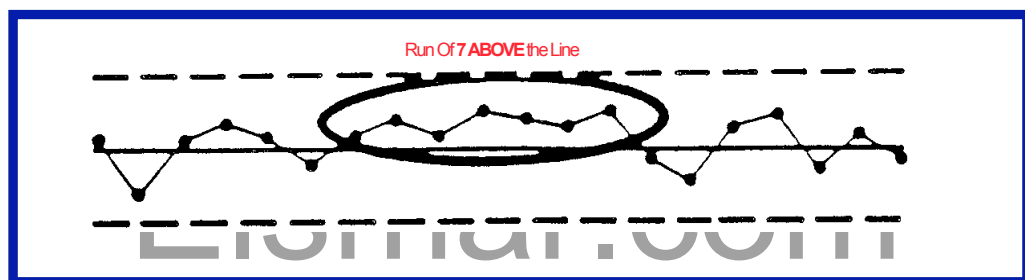
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## Notes & Commentary

# Interpreting Control Charts

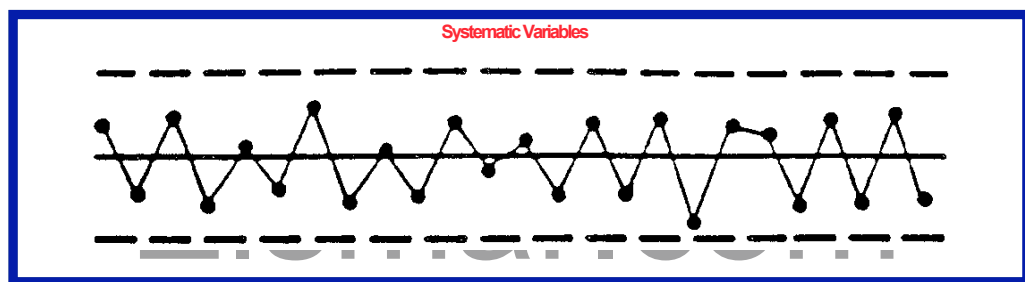


A Run of 7 successive points above or below the center line is an out of control condition.

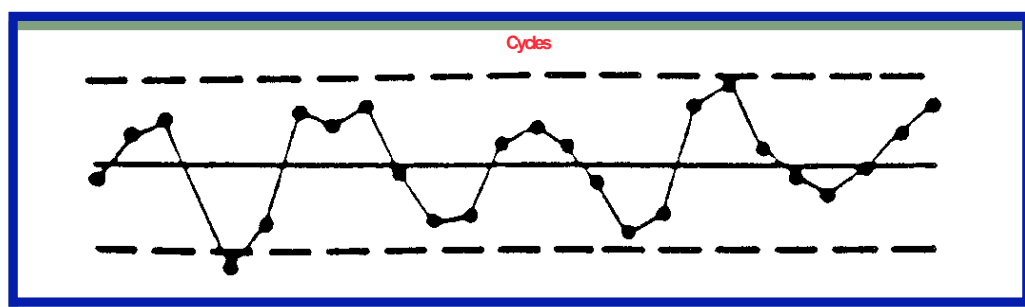


## Notes & Commentary

# Interpreting Control Charts



Predictable, Repeatable Patterns



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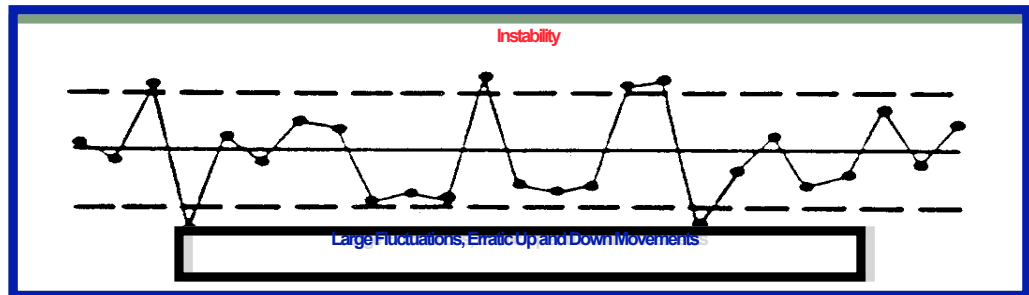
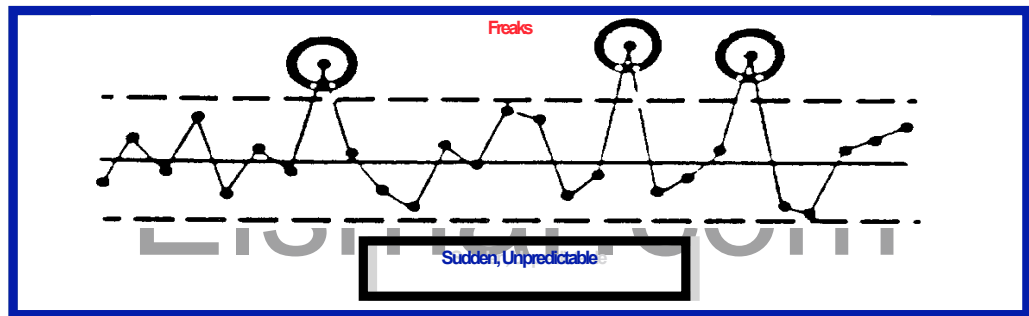
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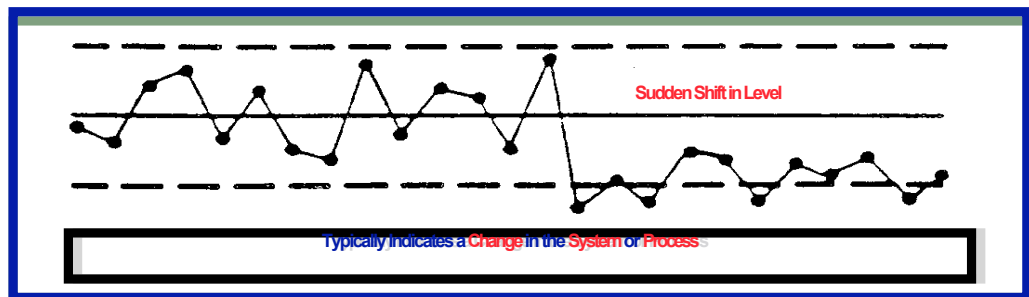
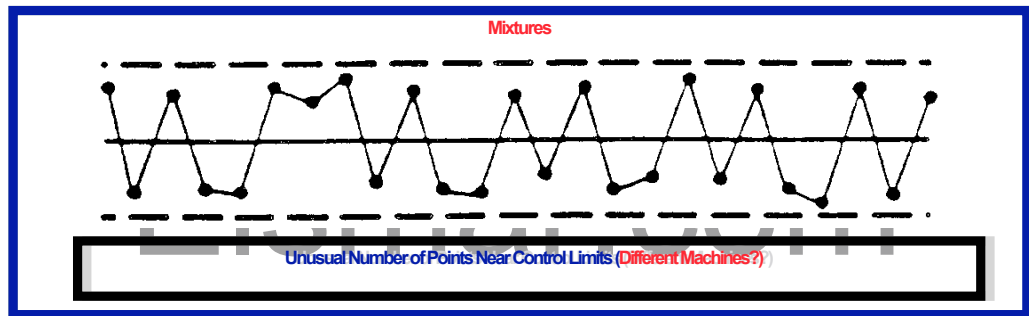
*Notes & Commentary*

# Interpreting Control Charts



*Notes & Commentary*

# Interpreting Control Charts



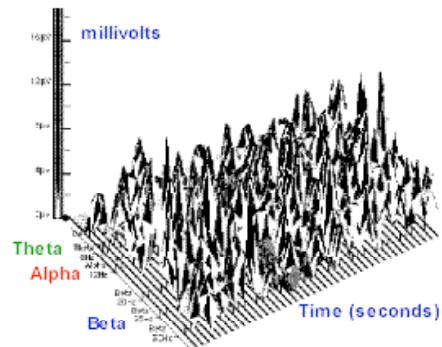
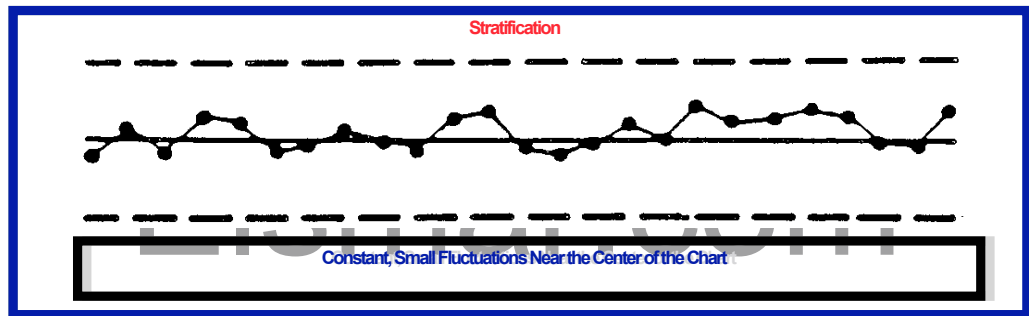
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## Notes & Commentary

# Interpreting Control Charts



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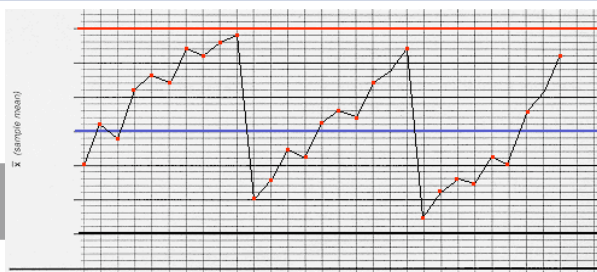
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# Interpreting Control Charts

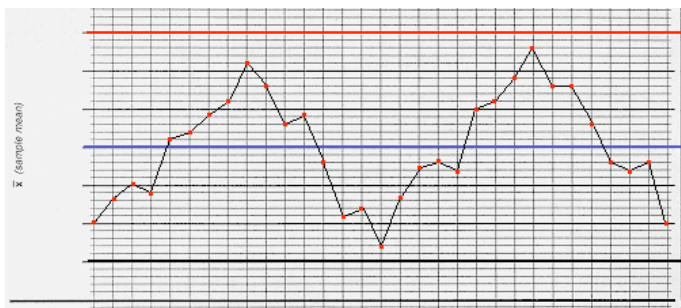
Drift

Sharp Breaks, Various  
Possible Causes



Cyclical

Possible Environmental  
(Seasonal?) Fluctuations



*Notes & Commentary*

# Control Chart Analysis Reaction

There is a wide range of **non-random patterns** that require action. When the presence of a special cause is suspected, the following actions should be taken (*subject to local instructions*).

## 1. CHECK

Check that all calculations and plots have been **accurately completed**, including those for control limits and means. When using variable charts, **check that the pair ( $\bar{x}$  bar, and  $\bar{R}$  bar) are consistent**. When satisfied that the data is accurate, **act immediately**.

## 2. INVESTIGATE

**Investigate the process operation to determine the cause.**

Use **tools** such as:

- Brainstorming
- Cause and Effect
- Pareto Analysis

Your **investigation** should cover issues such as:

- The method and tools for measurement
- The staff involved (to identify any training needs)
- Time series, such as staff changes on particular days of the week
- Changes in material
- Machine wear and maintenance
- Mixed samples from different people or machines
- Incorrect data, mistakenly or otherwise
- Changes in the environment (humidity etc.)

# Notes & Commentary



# Control Chart Analysis Reaction

## 3.ACT

Decide on appropriate action and implement it.

Identify on the control chart

The cause of the problem  
The action taken

As far as possible, eliminate the possibility of the special cause happening again.

## 4. CONTINUE MONITORING

Plotting should continue against the existing limits

The effects of the process intervention should become visible. If not, it should be investigated.

Where control chart analysis highlights an improvement in performance, the effect should be researched in order that:

Its operation can become integral to the process

Its application can be applied to other processes where appropriate

Control limits should be recalculated when out of control periods for which special causes have been found have been eliminated from the process.

The control limits are recalculated **excluding** the data plotted for the out of control period. A suitable sample size is also necessary.

On completion of the recalculation, you will need to check that all plots lie within the new limits

*Notes & Commentary*

## Define and Verify Root Cause(s)

- An investigation into all identified potential causes is necessary for effective problem solving. A **cause and effects diagram** can be used to brainstorm all potential causes of the described problem. The team should decide on what C&E diagram(s) is to be used: 5M, Process Flow and/or stratification. The more detailed the C&E diagram, the higher the chances the root cause will be included on the C&E diagram. An effective C&E diagram will include input from all team members and will be discussed in detail.
- Any **existing data should be reviewed** for clues to potential causes. Further data collection may be required to investigate additional causes.
- If the problem has not previously been seen, a **timeline analysis** should provide significant data. The timeline will identify events occurring about the time the problem developed. If enough documentation is available, potential causes can be further identified. For example, if a new operator was put on a process or if a new supplier began supplying parts. Investigation into the events occurring at the same time the problem was discovered could lead to several important potential causes.
- **“What Changed?” “ When?”** are important questions.

*Notes & Commentary*

## Define and Verify Root Cause(s)

- A technique used extensively in analytical problem solving is a **comparison analysis**. This analysis looks at what 'is' and what 'is not' in the problem description.
- Potential causes can be discovered by conducting a **survey**. By surveying the customer who has witnessed the problem, more potential causes can be highlighted.
- **Asking 'Why' repeatedly** is effective in driving the process toward root cause and generating more complete understanding of the cause and effect.

*Notes & Commentary*

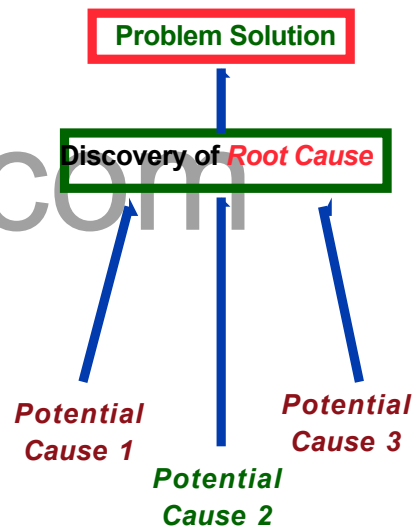
## Define and Verify Root Cause(s)

- Once the problem has been described and the potential causes identified, the team should be evaluated. Are the right members on the team to investigate the potential causes? Are technical advisors required to assist in any special studies? Do new team members need to be added? Is the authority to pursue the analysis of the potential causes well defined? All these questions must be answered to ensure the team will be successful in investigating the potential causes and determining the root cause.
- The cause and effect diagram is used to identify the potential causes to be investigated. What is the probability that a potential cause could be responsible for the problem? Identify all potential causes that could have been present and may have caused the problem.
- Once all potential causes have been agreed upon, choose several potential causes to investigate. If only one potential cause is investigated, a lot of time may be lost if that potential cause proves not to be the culprit. To expedite a solution, investigate several potential causes at the same time (Parallel actions on several potential causes).

*Notes & Commentary*

## Define and Verify Root Cause(s)

- If the problem is a manufacturing process, begin to establish a stable process. Once the process is stable, definition of the potential cause will be clarified.
- If design causes are identified, screening experiments may help identify the key variables which are affected by subsequent processes. Design changes may be appropriate.
- Four or five potential causes should be identified to investigate. Identifying several potential causes forces the team to address multiple possibilities rather than searching endlessly for a single cause. An implicit part of problem analysis is investigating potential causes in parallel rather than in series.



*Notes & Commentary*

# Hypothesis Generation



Collect Data

To determine importance of potential causes.

*Notes & Commentary*

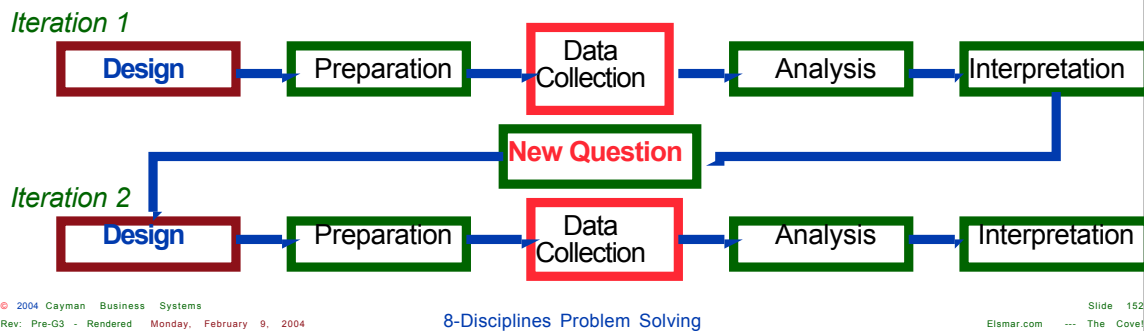
# Six Steps Of Investigation

- † State how the potential cause could have resulted in the described problem.
- † Establish what type of data can most easily prove or disprove the potential cause. Develop a plan on how the study will be conducted. Identify the actions on an action plan.
- † Prepare the required materials to conduct the study. Training may also be required.
- † Collect the required data.
- † Analyze the data. Use simple statistical tools emphasizing graphical illustrations of the data.
- † State conclusions. Outline conclusions from the study. Does the data establish the potential cause as being the reason for the problem?

*Notes & Commentary*

## Define and Verify Root Cause(s)

- † After the **cause and effect diagram** has been completed, data needs to be collected to determine which potential causes are important. Pareto diagrams and check sheets are very effective in establishing the importance of the potential causes.
- † Many folks are under the mistaken belief that data oriented problem solving can be accomplished by collecting data on a problem, analyzing the results and deciding the correct solution. Once data is collected and analyzed, new questions often arise so another data collection and analysis iteration is necessary. In addition, many problems can have more than 1 root cause. Data collected investigating one potential cause may not address other important potential causes. **Thus, several potential causes need to be studied using the data collection and analysis process.**



*Notes & Commentary*



## Define and Verify Root Cause(s)

- † Once the data has been collected and analyzed, **new potential causes often surface**. These potential causes should be pursued as soon as possible since they are suggested by the data.
- † The data collection for this step in the problem solving process can be as simple as **check sheets** or as sophisticated as **design of experiments**. The data analysis can rely heavily on simple graphical techniques such as histograms, pareto charts, control charts, stem-and-leaf and dot plots. **By using graphical tools, quick comprehension by all participants as well as accurately communicated information will result.** Comparison plots and stratified graphs are helpful in assessing stratification factors. To evaluate the relationship between characteristics, a scatter plot would be an effective tool.

*Notes & Commentary*

## Identify Alternate Solutions

- † Generate a Cause & Effects diagram.
- † Survey the customer.
- † Identify similar problem(s) previously solved.
- † Avoid implementing the interim actions for permanent actions /solutions.
- † Consider new and current technology for the solution.
- † Incorporate the solution into future products.

*Notes & Commentary*

## Define and Verify Root Cause(s)

- † After the root causes of a problem are identified, investigate methods to fix the problem. Evaluate several approaches to solve the problem. A thorough analysis of different approaches to eliminate a root cause is a critical part of the problem solving process.
- † The first approach to generate alternate solutions is to develop a cause and effect diagram. The team should brainstorm solutions. One alternative is to redesign the part or the manufacturing process. This approach should eliminate an opportunity for a problem to recur.
- † Communicate closely with the customer. How the root cause is eliminated might impact the customer in some unforeseen way. Customers should have a chance to input their needs into the problem solution.

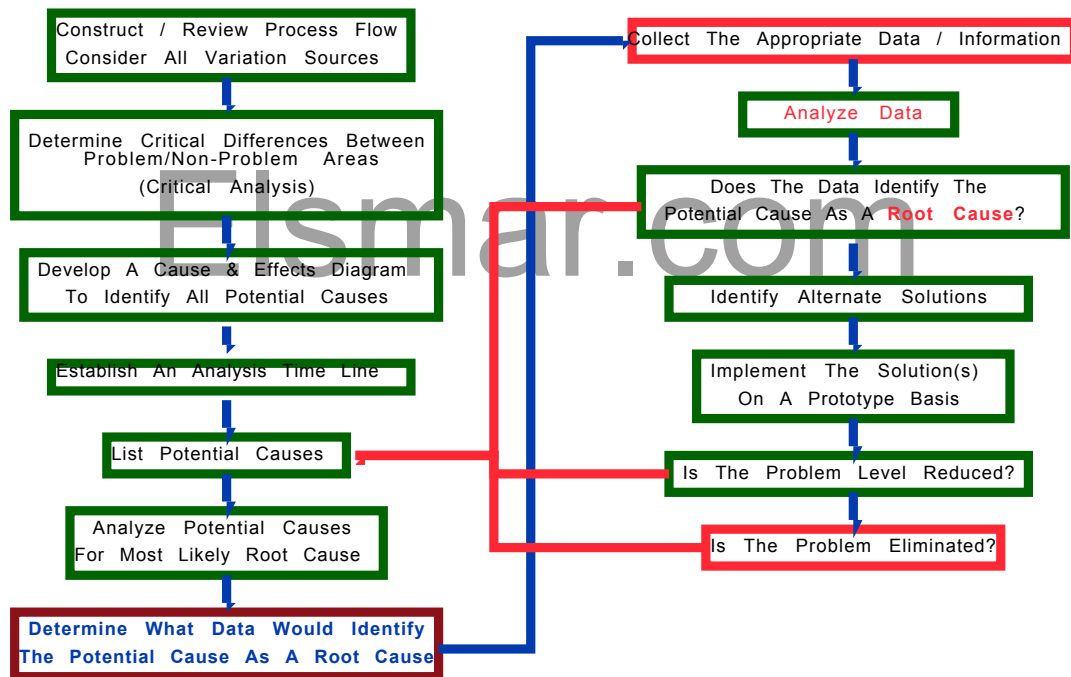
*Notes & Commentary*

## Define and Verify Root Cause(s)

- † If **similar problems** have been **previously identified and solved**, assess those solutions. As part of every investigation, identify similarly engineered parts or plant processes that may have experienced this problem. Again, these could be a source of alternative solutions.
- † **Avoid 'band-aid' fixes** - this will help prevent future recurrence of the problem. Sometimes due to cost and/or product life a compromise is to implement interim actions permanently. However, this is considered the least acceptable solution.
- † As part of investigating problem solutions, the team should **look at new and current technology** around an engineered part and/or the manufacturing process. New alternatives could come from advances in these areas. In some cases a thorough understanding of the current design and/or manufacturing processes produce efficient solutions. The team should remember that the solution needs to be incorporated in future products.

*Notes & Commentary*

## Define and Verify Root Cause(s)



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*Notes & Commentary*

## Identify Potential Causes - Cause & Effects Diagram

- Define the 'effects' for cause and effect diagram(s).
- Prepare a 5M, Process or Stratification cause & effects diagram for each effect (you may want to use a combination).
- Team members should each assume their activity causes the problem and ask themselves "How could what I do possibly generate the problem?"
- Prepare a [time line analysis](#) if the problem was not always present. Identify what changed when.
- Perform a [comparison analysis](#) to determine if the same or a similar problem existed in related products or processes. Identify past solutions and root causes which may be appropriate for the current problem.
- Identify the top few potential causes. Develop a plan for investigating each cause and update the action plan.
- Evaluate a potential cause against the problem description. Does a mechanism exist so that the potential cause could result in the problem?

*Notes & Commentary*

# Analyze Potential Causes - Validate Root Cause

## Analyze Potential Causes

- Use the iterative process to analyze each potential cause.
  - △ Hypothesis generation: How does the potential cause result in the problem?
  - △ Design: What type of data can most easily prove/disprove the hypothesis?
  - △ Preparation: Obtain materials and prepare a check list.
  - △ Data Collection: Collect the data.
  - △ Analysis: Use simple, graphical methods to display data.
  - △ Interpretation: Is the hypothesis true?
- Investigate several potential causes independently.
- Use an action plan to manage the analysis process for each potential cause being studied.

## Validate Root Causes

- Clearly state root cause(s) and identify data which suggests a conclusion.
- Verify root cause factors are present in the product and/or process.
- Conduct with / without study to verify root cause. Can you generate the problem?

*Notes & Commentary*

## Potential Causes - Some Questions

- Have you identified all sources of variation on the flow diagram?
- Have all sources of information been used to define the cause of the problem?
- Do you have the physical evidence of the problem?
- Can you establish a relationship between the problem and the process?
- Do you continually challenge the potential root causes with the question 'why' followed with 'because' to construct alternatives?
- What are the is / is not distinctions?
- Is this a unique situation or is the likely problem similar to a past experience?
- Has a comparison analysis been completed to determine if the same or similar problem existed in related products?
- What are the experiences of recent actions that may be related to this problem?
- Why might this have occurred?
- Why haven't we experienced this problem before?

*Notes & Commentary*



## Analyze What Has Changed

- Manufacturing
  - △ New supplier(s)?
  - △ New tool(s)?
  - △ New operator(s)?
  - △ Process change(s)?
  - △ Measurement system?
  - △ Raw material(s)?
  - △ Vendor supplied part(s)?
  - △ Do other plants have a similar problem?
- Engineering
  - △ Any pattern to the problem?
  - △ Geographically?
  - △ Time of year?
  - △ Build date(s)?
  - △ Did the problem exist at program sign-off?
  - △ Was it conditionally signed off?
  - △ Did the problem exist during pre-production prototypes, functionals?

*Notes & Commentary*

## Data and Root Causes

- What data is available to indicate changes in the process?
- Does data exist to document the customer's problem?
- If the potential cause is the root cause, how does it explain all we know about the problem?
- What is the likelihood that each potential cause could explain the described problem?
- What is the concern that the potential cause is actually occurring?
- What actions have been taken to the potential causes to assure their presence?

*Notes & Commentary*

# Product - Process Assumptions

- *Assumptions:*

- Features

- Design

- Process concepts

- Technical innovations

- Advanced materials

- Reliability assessments

- New technology

- Document *assumptions* as part of project plan
- Utilize as inputs to plan
- *Consider alternate paths* in case *assumptions* do not play out

*Notes & Commentary*

# Errors 1

**Almost all errors are caused by human error.**

- **Forgetfulness** - Sometimes we forget things when we are not concentrating.  
*Example:* A person forgets to set his/her alarm clock at night. *Safeguard:* Establish a routine which includes checking before going to bed.
- **Errors due to misunderstanding** - Sometimes we make mistakes when we jump to the wrong conclusion before we're familiar with the situation.  
*Example:* A person used to a stick shift pushes the brake pedal in an automatic thinking it is the clutch. *Safeguards:* Training, checking in advance, standardizing work procedures.
- **Errors in identification** - Sometimes we misjudge a situation because we view it too quickly or are too far away to see it clearly. For example, a \$1 bill is mistaken for a \$10 bill. *Safeguards:* Training, attentiveness, vigilance.

*Notes & Commentary*

## Errors 2

- **Errors made by amateurs** - Sometimes we make mistakes through lack of experience. Example: A new worker does not know the operation or is just barely familiar with it. Safeguards: Training, skill building, work standardization.
- **Willful errors** - Sometimes errors occur when we decide that we can ignore the rules under certain circumstances. Example: Crossing a street against a red light because we see no cars. Safeguards: Basic education, experience.
- **Inadvertent errors** - Sometimes we are 'absent minded' and make mistakes without knowing how they happened. Example: Someone lost in thought tries to cross the street without even noticing whether the light is red or not. Safeguards: Attentiveness, discipline, work standardization.
- **Errors due to slowness** - Sometimes we make mistakes when our actions are slowed down by delays in judgment. Example: A person learning to drive is slow to step on the brake. Safeguards: Skill building, work standardization.

*Notes & Commentary*

## Errors 3

- **Errors due to lack of standards** - Some errors occur when there are not suitable instructions or work standards. Example: A measurement may be left to an individual's discretion. Safeguards: Work standardization, work instructions.
- **Surprise errors** - Errors sometimes occur when equipment runs differently than expected. Example: A Machine malfunction without warning. Safeguards: Total Productive Maintenance, work standardization.
- **Intentional errors** - Some people make mistakes deliberately. Crimes and sabotage are examples. Safeguards: Fundamental education, discipline.

Mistakes happen for many reasons, but **almost all can be prevented** if we take time to identify when and why they happen and then take steps to prevent them by using Poka-Yoke methods with consideration to other available safeguards.

*Notes & Commentary*

# Process Failure Causes

1. Omitted processing
2. Processing errors
3. Errors setting up work piece maintenance
4. Missing parts
5. Wrong parts
6. Processing wrong work piece
7. Mis-operation
8. Adjustment error
9. Equipment not set up properly
10. Tools and/or fixtures improperly prepared
11. Poor control procedures
12. Improper equipment
13. Bad recipe
14. Fatigue
15. Lack of Safety
16. Hardware failure
17. Failure to enforce controls
18. Environment
19. Stress connections
20. Poor FMEA(s).

*Notes & Commentary*

# Process Control Examples

1. Standardized work instructions/procedures
2. Fixtures and jigs
3. Mechanical interference interfaces
4. Mechanical counters
5. Mechanical sensors
6. Electrical/Electronic sensors
7. Job sheets or Process packages
8. Bar coding with software integration and control
9. Marking
10. Training and related educational safeguards
11. Visual Checks
12. Gage studies
13. Preventive maintenance
14. Automation (Real Time Control)

Controls can be process controls such as fixture fool-proofing or SPC, or can be post-process inspection / testing.

Inspection / testing may occur at the subject operation or at subsequent operation(s) that can detect the subject failure mode.

*Notes & Commentary*



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## The Poka-Yoke System

Is **Zero Defects** a Reality?

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*Notes & Commentary*

## We have Quality Problems!

In American manufacturing, this statement leads to an unsatisfactory resolution to the problem. "We have Quality Problems" shifts the concerns from the undetermined true source (operation & process) to an area where the root cause never occurred (Quality Control) and the true cause is addressed and corrected through high cost inspection methods.

## Notes & Commentary

It has been my experience that...

When difficulties in product arise, Quality Control usually finds it, analyses it, and reports the results to management. This process is fine, it is Quality's Job to do this. What ends up happening in some situations is Quality ends up owning the Problem. The use of Statistics helps to keep the Problem alive.

Although SPC is a good tool for identifying problems it does very little to prevent them from happening. We see week after week of process and product monitoring with small improvements being made but not major jumps. What could be missing?

What we see happening is a Fire. Quality confirms the fire, monitors its progress and everyone tries to put out the fires. Juran termed this sporadic problem solving. we use containment practices, but what truly ends up happening, is we all stand around and watch it burn.

## We Have a Quality ~~Problem!~~

If we review the manufacturing structure and the functioning elements to which the product is going to be exposed to, we will be able to determine possible **root causes** to the problems prior to production. This is known as **Quality Planning** and if done properly *can eliminate the need for the Quality Control.*  
(Man, Material, Machine, Method, or Measurement)

## Notes & Commentary

This is more in line with what Juran termed Chronic Problem Solving. We need to change the present situation and use a team approach. Quality is not the means to the end, it is simply a point in the process. To find the real problem, we need the Process and Operation Experts, we must look at the whole manufacturing structure and develop a team focus.

## Section One

# Shingo And The Manufacturing Structure

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*Notes & Commentary*

## Poka Yoke Defined

Shigeo Shingo defines Poka Yoke as:

- Poka  
“Inadvertent Mistake That Anyone Can Make”
- Yoke  
“To Prevent or Proof”

## Notes & Commentary

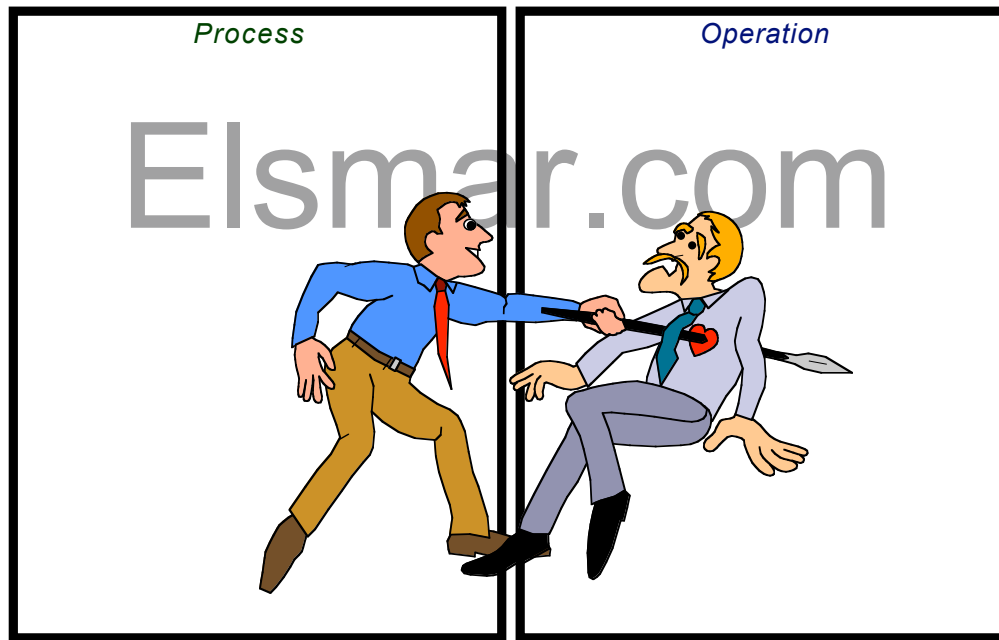
Shigeo Shingo, a Japanese Industrial Engineer, contributed many concepts to modern Management and Manufacturing practices. Some of these included the creation of:

- \* Zero Quality Control “Shipping No defects”
- \* Sequence Inspection “Checking previous work, Prior to starting your task”
- \* Source Inspection “Checking ones own work”
- \* Poka Yoke “Mistake Proofing”
- \* SMED (Single Minute Exchanges of Dies)

Although he did not create the concepts of Sequence and Source Inspection, Shingo developed a structure of knowing which to use when.

# Process vs. Operation

*Manufacturing is a network of two structures. Problems Occur When They Disagree!*



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## Notes & Commentary

To obtain the proper base of Shingo's work, we must adopt the Japanese mind set of manufacturing which differs (Thank GOD) from Frederick W. Taylor.

Japanese view manufacturing as a network consisting of two interrelated structures.

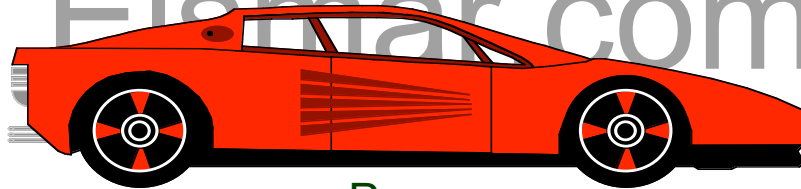
**The Process Structure:** the flow by which raw materials are converted into finished goods. Within the process structure, there are *four categories* to which a process goes through.

**The Operation Structure:** the actions performed on materials. *Three categories* can be occurring within the operation structure. Preparation and After Preparation adjustments, Principal Operations, Marginal Allowances.

# Operation & Process

## Operation

Some People Know How to Drive a Car! Driving is an **Operation**.



## Process

Some People Know How to Repair a Car! Repairing is a **Process**.



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## Notes & Commentary

Most People Know How to Drive a Car!

Abilities and Tasks differs:

Race car driver

Truck Driver

Sunday Driver

Abilities and Task Differ:

Designers

Repairers

Builders

# Categories of the Process Function

A **Process** is the flow by which raw materials are converted into finished goods.

Processes fall into one of the following categories:

**Work:** Assembly, disassembly, alter shape or quality

**Inspection:** Comparison with a standard

**Transportation:** A change of location

**Delay:** Time during which no work, transportation or inspection takes place

- **Process Delays** :Lot does not move until last item finished in process
- **Lot Delays**: lot delayed in order to maintain 100, 99, 98 ... 2,1,0

*Notes & Commentary*



# Categories of the Operation Function

**An Operation is an action performed on material within the process.**  
Operations fall into one of the following categories:

**Preparation/Adjustments Phase:**(setup, tool change, adjustments)

**Principal Operations Phase:** Operations repeated in each cycle (hole punch, drill, sheer)

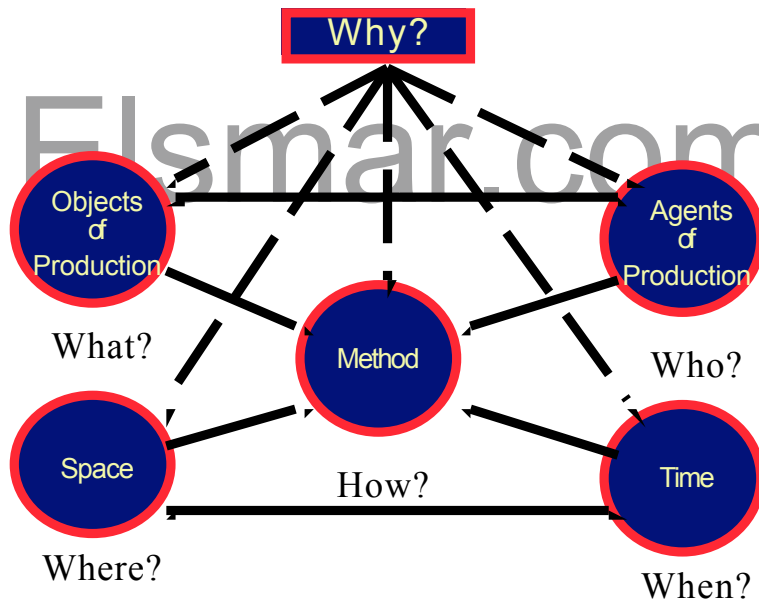
- Main Operations (stamping, cutting)
- Incidental Operations (movement of press, movement of people)

**Marginal Allowances:**

- Fatigue
- Hygiene (wash hands, etc.)
- Operations (shut-down to produce rush order, meetings)
- Work place (breaks, cleaning, maintenance)

*Notes & Commentary*

## 5 Elements of Production



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## Notes & Commentary

### **Objects** of Production: The Product

Materials, Semifinished & Finished Goods

**Agents** of Production: The people in charge of Product, The Machines, Tools, and other equipment assisting them.

Man, Machines, Tools, Jigs, Gaging

**Methods:** Means by which actions are performed

Work Instructions, Procedures, Manuals

**Space:** Where actions are performed and the locations to and from which objects are transported.

Processing system, Balanced Load and Capacity, Processing Condition

**Time:** The timing of work or how long action take.

Time and Timing

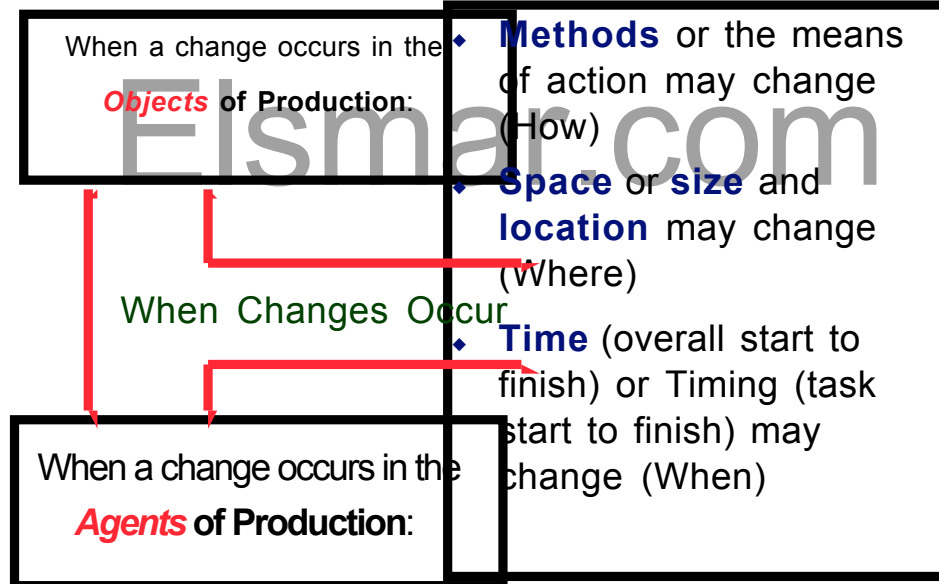
## Defining The 5 Elements

- ♦ **Objects of Production:** Materials: Raw, Finished, Semi-finished, In-process
- ♦ **Agents of Production:** People, Machines, Tools, Jigs, Machine Tools, Incidental Devices, Inspection Equipment, The Environment, etc.
- ♦ **Methods:** Processing System, Load & Capacity Balance, Processing Conditions
- ♦ **Space:** Left to Right, Front to Back, Top to Bottom
- ♦ **Time:** Process Time, Production Time, Task Time

*Notes & Commentary*

## Changes in the Elements






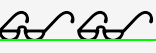

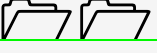




















When Changes Occur, **Balance** Must be Achieved Again



*Notes & Commentary*

## 4 Process Phenomena's

### Delays

Process	Work	Inspection	Transprotation	Storage
<b>Operation</b>				
Planning, Prepatin. & Adjustment Operations (setup Operations)				
<b>Principal Operations</b>				
Main				
Incidental				
<b>Margin Allowances</b>				
Fatigue				
Hvqiene				
Operations				
Workplace				

*Notes & Commentary*

# Shigeo Shingo's Five Questions

**A Problem (or Delay) Occurs ask**

- Why? Describe.
- Why? Describe.
- Why? Describe.
- Why? Describe.
- Why? Response!

## Notes & Commentary

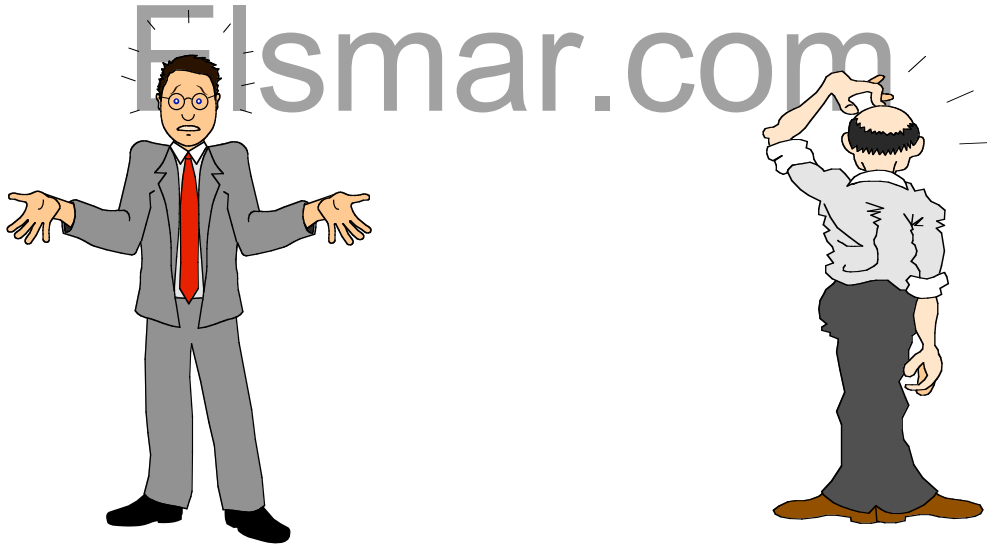
### Shigeo Shingo

Mr. Shingo distinguished himself as one of the world's leading experts in improving manufacturing processes. He has been described as an "engineering genius" who assisted in the creation of, and wrote about, many of the features of the revolutionary just-in-time manufacturing methods, systems, and processes which make up the renowned Toyota Production System and related production systems.

The Shingo Prize is named for the Japanese industrial engineer, Shigeo Shingo. His greatness was in his ability to understand exactly why products are manufactured the way they are, and then transform that understanding into a workable system for low-cost, high-quality production. Mr. Shingo died peacefully November 14, 1990 at the age of 81.

## Section Two

Is There a Difference Between An **Error** and a **Defect**?



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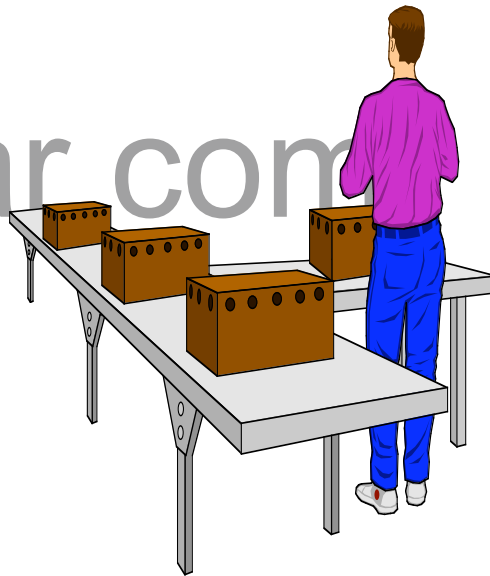
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*Notes & Commentary*

## Reasons Why We Don't Need Poka Yoke

- ◆ Workers Possess Divine Infallibility
- ◆ Implementation Costs are High
- ◆ The World is not a Dynamic Environment
- ◆ It is Cheaper to Hire Sorters
- ◆ Quality Control & Production Would Have Nothing To Do
- ◆ We are All Too Busy
- ◆ We use SPC for Improvements



*Notes & Commentary*



## Separating Error From Defect

- ♦ **Humans** Make Errors (Cause), Defects Arise Because Errors Are Made (Effect).
- ♦ It is **Impossible** to Eliminate Errors From Tasks Performed by Humans.
- ♦ Errors Will Not Turn into Defects if Feedback and Action Takes Place at The Error Stage.
- ♦ Changing Occurrences can reduce Reoccurrence

## Notes & Commentary

Humans make errors (**Cause**), defects arise because errors are made (**Effect**).

It is impossible to eliminate defects from tasks performed by humans.

Yet errors will not turn into defects if feedback and action takes place at the error stage.

The difference between Occurrence and Reoccurrence

The Paint Story "What Did You Learn"

The Hammer Story "Hurts More The Second Time"

My Brother & His Stuck Car

The Paint Bucket was an Occurrence, I bring the Paint Can Down with me.

The Hammer is an on going Reoccurrence, I need to buy an Automatic Nail Gun.

My Brother is another story.

# Causes of Defects

- **Process Defects**

Process Failure

- Operational or Procedure Failures

Process Error

- Incorrect or Imprecise

- **Product Defects**

Incomplete Product

Substandard Product

*Notes & Commentary*

## Levels of Defects

- ◆ **Level 1:** Defects Shipped out of Factory (Taylor Methods)
- ◆ **Level 2:** Defects Kept within Factory (Sheward Methods)
- ◆ **Level 3:** Defects Reduced (Juran/Demming Methods)
- ◆ **Level 4:** Defects Kept within Production Stage (Juran/Demming Methods)
- ◆ **Level 5:** Defects Not Produced (Shingo Methods)

*Notes & Commentary*

## Section Three



### Inspection

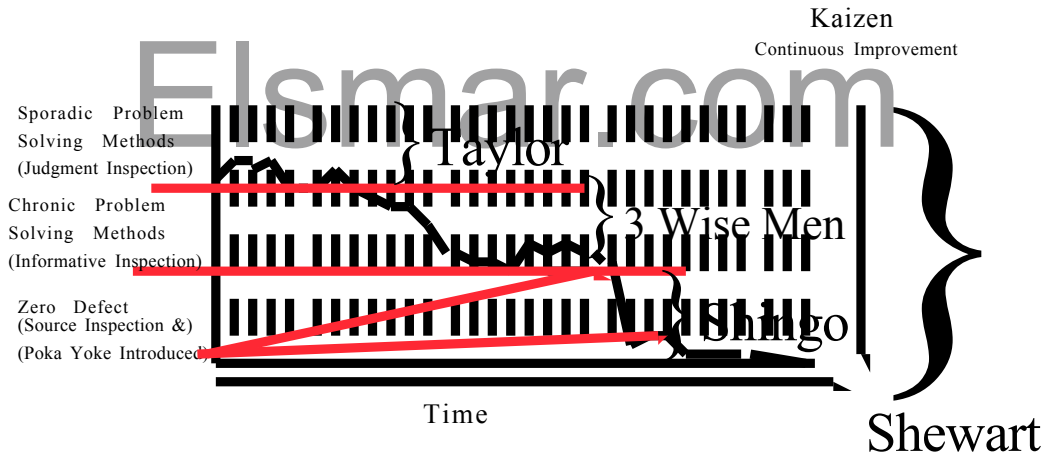
Taylor's Plan

Shewhart, Demming & Juran's Plan

Shingo's Plan

*Notes & Commentary*

# Inspection Philosophies



*Notes & Commentary*

### 3 Methods of Inspection

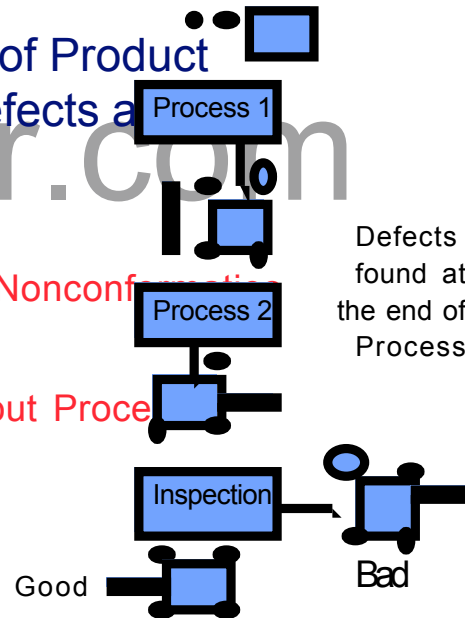
- Judgment Inspection (Taylor's)
  - › Inspection That Discovers Defects
- Informative Inspection (Shewhart's)
  - › Inspection That Reduces Defects
- Source Inspection (Shingo's)
  - › Inspection That Eliminates Defects

*Notes & Commentary*

# Judgment Inspection

Attribute Inspection of Product  
Which Discovers Defects at  
End of the Process

- Rework Costs
- Process Costs of Nonconformities
- Scrap Costs
- No Information about Process



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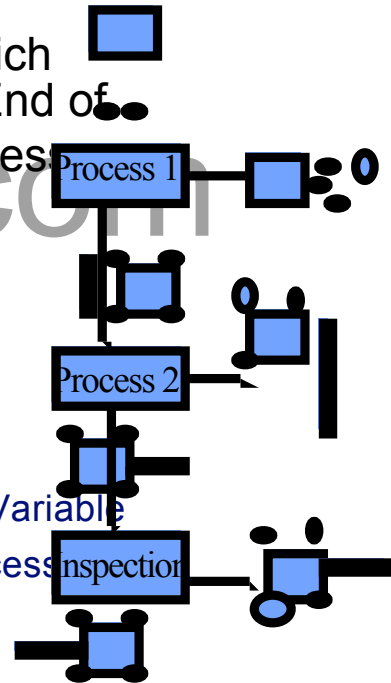
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*Notes & Commentary*

# SPC Inspection

Inspection of Product Which  
Reduces Defects at the End of  
Process Using Inner Process  
Checks

- Inspection Costs
- Delay Costs
- Extra Equipment Costs
- Scrap Cost Reduced
- Information (Grading or Variable Data) Gained about Process



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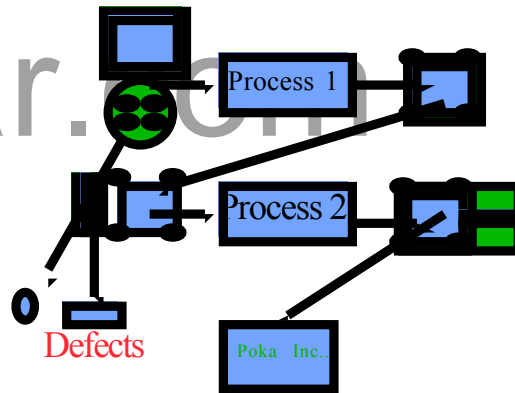
*Notes & Commentary*



# Source & Sequential Inspection

Inspection Built into the  
Operation using Poka Yoke  
Devices to Detect Errors  
Before They Become Defects

- ° Pushes Defect Detection Up-front.  
Cost Reduced
- ° Nonconforming Materials are not  
processed.
- ° Eliminates need for SPC
- ° Minimal Cost of Poka Yoke Devices
- ° Reduces Steps in Process



*Notes & Commentary*

## Section Four



Efficiency & Waste

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*Notes & Commentary*

# Production Efficiency & Waste

- *Melody*  
Flow Production
- *Rhythm*  
Tack Time (Level Production)
- *Harmony*  
Standard Operation Man,  
Machine, Material, Method,  
Measurement

✱ Any Element Missing or  
Incomplete: We Have **Noise**.  
(Waste)



*Notes & Commentary*

## Types of Waste

- ◆ Stock Inefficiency
- ◆ Excess Stock Parts & Materials
- ◆ Transportation Inefficiencies
- ◆ Inefficient worker movement
- ◆ inefficient results from looking for things
- ◆ Selection inefficient
- ◆ Defective production

*Notes & Commentary*

# Cost Contributing to Waste

Materials

Processing

Depreciation

Repairs

Transportation

Recalls

Replacement

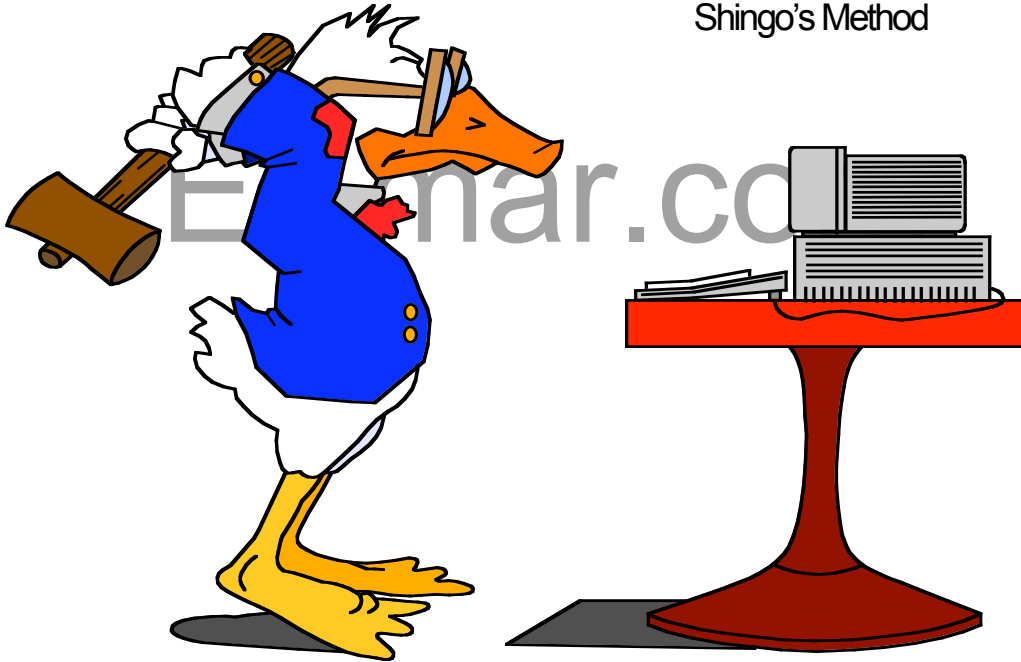
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## Section 5

Shingo's Method



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*Notes & Commentary*

## Shingo's Method

- ◆ A Poka Yoke System uses Poka Yoke Devices Built into Source or Sequential Inspection Methods.
- ◆ Properly Implemented, the System Can Achieve:

**Zero Defects**

**Zero Waste**

**Zero Delays**

*Notes & Commentary*

# Poka Yoke Devices, Systems & Inspection

## Poka Yoke Systems

- ♦ **Control Systems**

Halt the operations, and require feedback and action before process can resume.

- ♦ **Warning Systems**

Uses signals to warn the operator that the operations needs feedback and action

*SQC systems have fairly long periods of time between check stages and feedback execution*

*Notes & Commentary*



# Poka Yoke Devices, Systems & Inspection

## Poka Yoke Devices

- ◆ Are Built within the Process
- ◆ In General Have Low Cost
- ◆ Have the Capacity for 100% Inspection

Remember SQC is performed **outside** the process which adds cost and allows defects to escape the system.

*Notes & Commentary*

# Every Day Examples



New lawn mowers are required to have a safety bar on the handle that must be pulled back in order to start the engine. If you let go of the safety bar, the mower blade stops in 3 seconds or less. This is an adaptation of the "dead man switch" from railroad locomotives.

## Computer Files

**Microsoft:** File type identified by file name suffix. If one does not add the correct suffix, the program the file is from will not recognize it.

**Macintosh** Poka Yoke (1984): File type and creator application are identified and *embedded in* the first part of every file. File name plays NO part in recognition by the originating program.

## Computer Floppy Drives

**Microsoft:** Disk must be inserted and ejected by hand. It is possible to eject a disk while it is being written to.

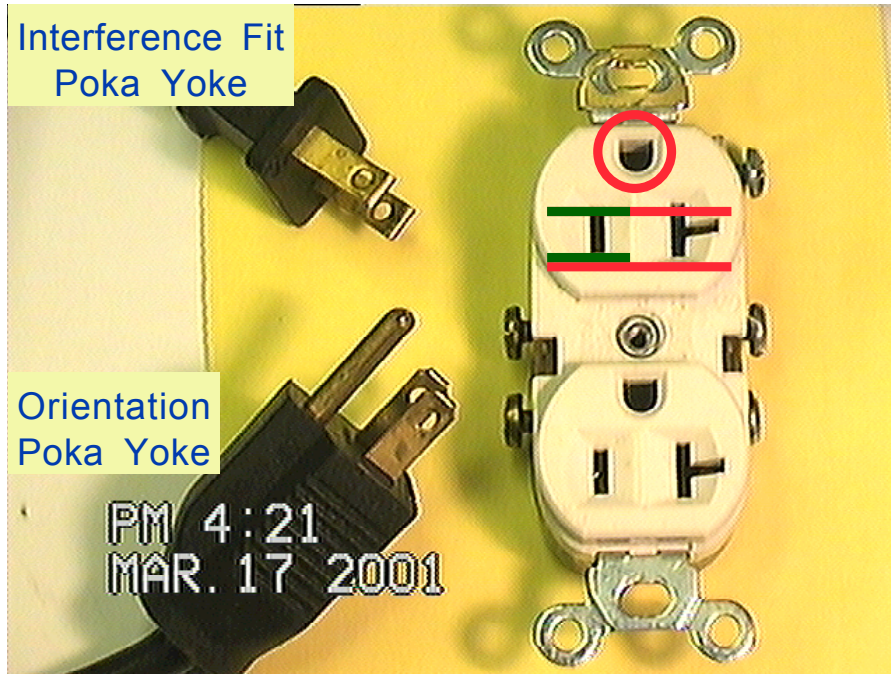
**Macintosh** Poka Yoke (1984): Disk drive grabs disk as it is being inserted and draws it in and seats it. Disk cannot be manually ejected. You must drag the 'desktop' icon for the disk to the 'Trash'. The drive then ejects the disk as long as there are no disk operations taking place.



Warning lights alert the driver of potential problems. These devices employ a warning method instead of a control method.

Notes & Commentary

# Electrical Polarity Poka Yokes



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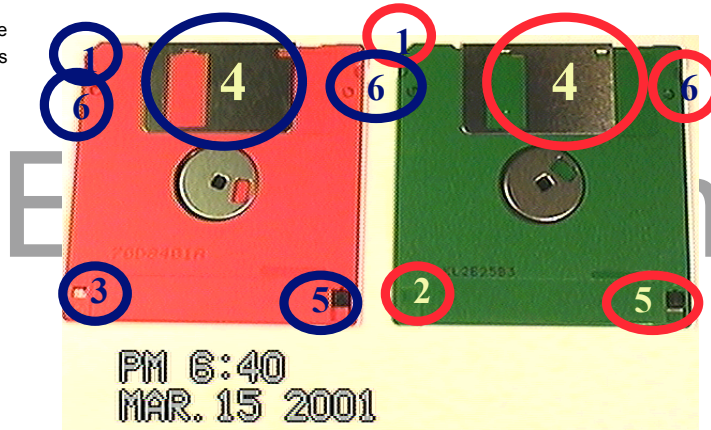
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*Notes & Commentary*

# Floppy Disk Poke-Yokes

Floppy disks have many poka-yokes built in. One example is you cannot insert the disk into the drive completely if the disk is upside down. This is because of the corner notch [#1].

720k disks have no hole [#2] while HD disks have hole (mechanism senses)[#3].



Spring loaded shutter mechanism - Do you remember the old 5.25 inch floppies from the early to mid-1980s? Failsafe disk surface protection [#4].

Slide Tab to protect against erasure. Mechanism senses [#5].

'Precision' alignment. Disk alignment holes and notches [#6] ensure the disk is properly aligned and also provides a 'focus' area for manufacturing.

*Notes & Commentary*

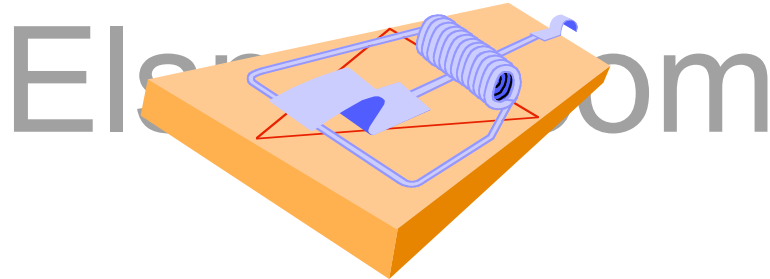
# Poka Yoke Devices, Systems & Inspection

## Inspection with Poka Yoke

- Source Inspection (ZQC)
  - Built into process
  - Leads to a zero defect Systems
- Self Check Informative Inspections (SQC)
  - Built inside or outside immediate process
  - Reduces defects to a minimum
- Successive Check Informative Inspection (SQC)
  - Built inside or outside sequential process
  - Reduces defects to a minimum

*Notes & Commentary*

## Section 6



Tools For Assessment

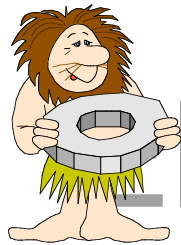
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*Notes & Commentary*

# Organizing Systems for Zero Defects



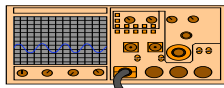
People



Materials



Methods



Machines



Information



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## Notes & Commentary

## Questions to Ask About Present Systems

- ◆ Can we take current informative inspection systems with successive checks and improve them to get a system of informative inspections with self-check methods?
- ◆ Can we take current informative inspections with self-check methods and improve them to get source inspection?
- ◆ Since informative inspections tolerate the occurrence of defects, can we take these methods and improve them to get source inspection in which the errors that cause defects are detected and prevented from turning into defects.

*Notes & Commentary*



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D5

## Choose, Implement & Verify Corrective Actions

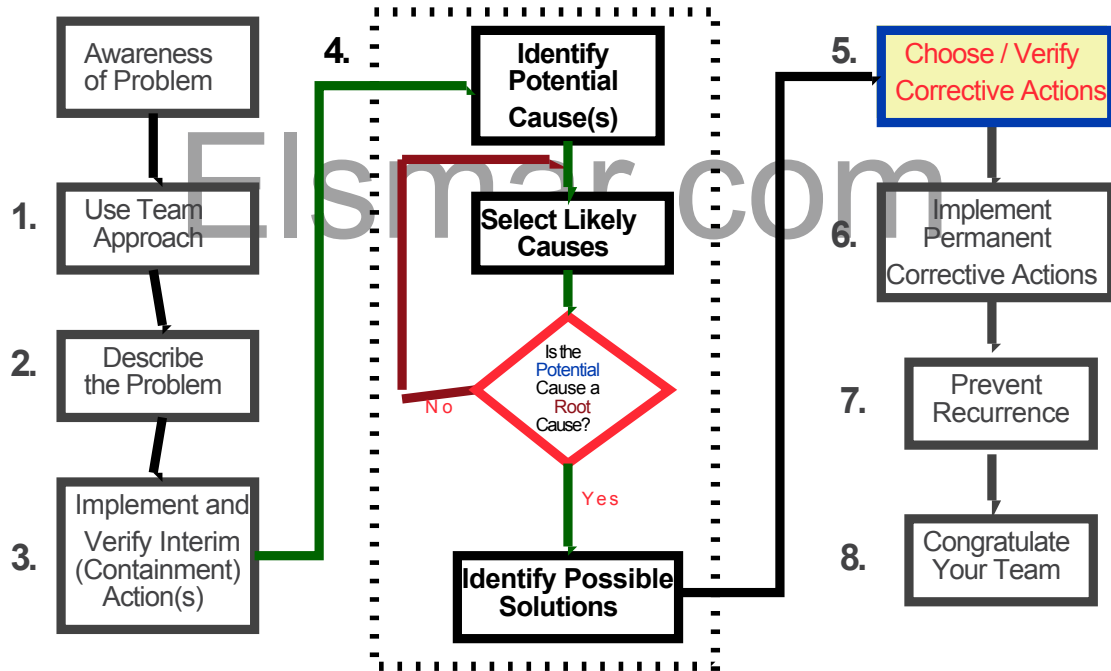
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*Notes & Commentary*

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*Notes & Commentary*

## Choose, Implement & Verify CA Objective

- † Through pre-production test programs quantitatively confirm that the selected corrective actions will resolve the problem for the customer, and will not cause any undesirable side effects.
- † Define contingency actions, if necessary, based upon Risk Assessment.

*Notes & Commentary*

## Choose, Implement & Verify Corrective Actions

- † By far the most critical step in the problem-solving process is to **verify that the solution will in fact eliminate the problem**. In addition, it is often the **most difficult step**. The most common method to evaluate a problem solution is to wait for implementation of the solution, then see if the problem goes away. However, too much time may be lost before conclusive information is available. Verification, where ever possible, should come before implementation.
- † Several **approaches to verification** are available. In engineering, design verification and production validation testing provides significant information. In the short term, a bench/lab test can be used to verify. In some cases dynamometer testing can provide verification. Long term one can monitor fleet response. For manufacturing, verification is by in-plant indicators. SPC can verify the elimination of the problem. Sometimes scrap rate reports and conformance audits provide information. Sometimes a designed experiment is part of verification.

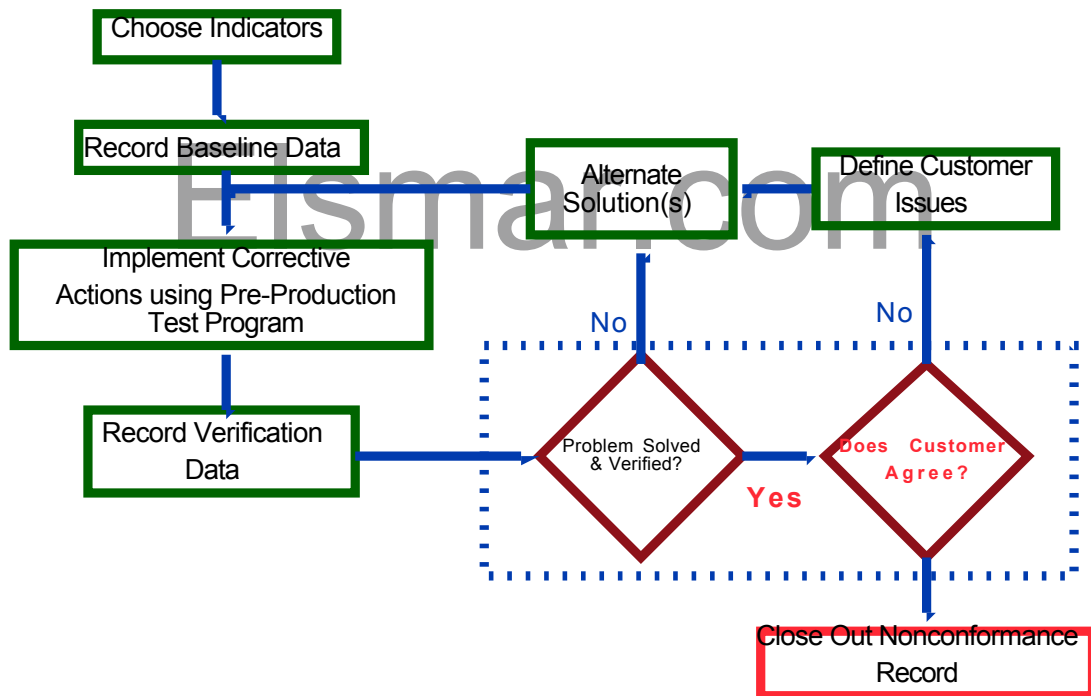
*Notes & Commentary*

## Choose, Implement & Verify Corrective Actions

- Whatever verifications you choose, a detailed verification / action plan is required to outline **who** will be taking **what** actions by **when**. The action plan should show what data or statistics will be collected and analyzed, who is responsible and must track actual progress and scheduled completion. The action plan is the detailed Dynamic record of all phases of the problem solving process.
- Good problem solution **verifies the customer is satisfied with the solution**. If possible, involve the customer in choosing solutions.
- All verification of the problem solution will require **decision analysis**. Decision analysis is part of the cost and timing consideration of the solution. Decisions affecting cost must include effects on quality, future problem recurrence and complete elimination of the problem. In addition, management and operating procedures may be involved when choosing the solution. Evaluation of any adverse effects caused by the solution are important. The FMEA will most surely be affected.

*Notes & Commentary*

## Choose, Implement & Verify Corrective Actions



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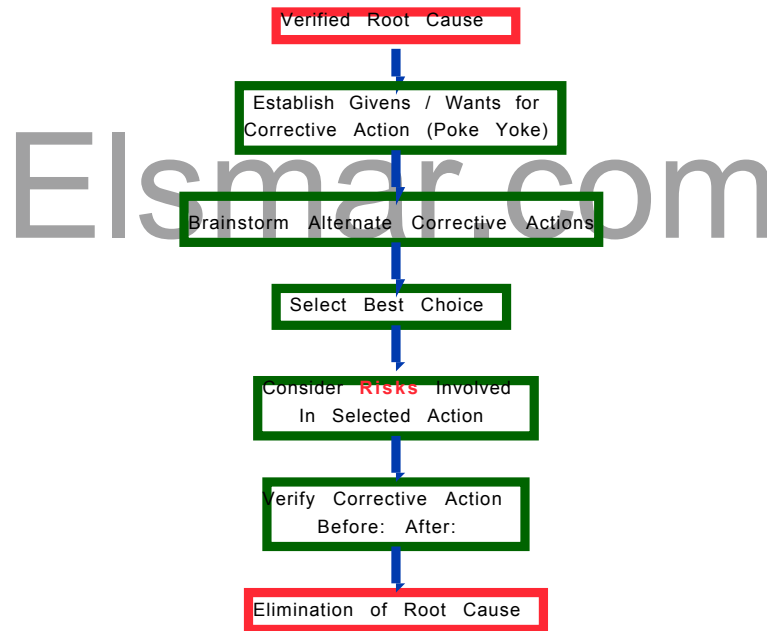
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# Notes & Commentary

## Choose, Implement & Verify Corrective Actions



*Notes & Commentary*

## Choose, Implement & Verify Corrective Actions

### Run Pilot Tests

- Artificially simulate the solution to allow actual process or field variation.
- Field test the solution using pilot customer groups.
- Verify carefully that another problem is not generated by the solution.

### Monitor Results

- Quantify changes in key indicators.
- Stress the customer / user evaluation.

*Notes & Commentary*



## Confirmation Questions

- Can you list and measure all of the indicators related to the problem?
- Which of the indicators are most directly related to the problem? Can you use the indicators to measure problem severity?
- Can you determine how often or at what intervals to measure the problem (hourly, shift, daily, weekly, monthly)?
- If there are no changes to the indicators after taking action, can you determine what to do? Will you need to take cause, action and verification measures?
- Do all indicators reflect conclusive resolution?
- Has the team prioritized the customer / user evaluation after implementation?
- What scientific methods are being used to verify effectiveness in the short term and to predict the outcome long term?

*Notes & Commentary*

## Verification Questions

- Has the customer been contacted to determine a date when verification will be evaluated?
- What data has been established for follow-up?
- Has a time-line (project) chart been completed?
- Have field tests been conducted using pilot customer groups?
- Have dates been established when verification of effectiveness will be evaluated?

*Notes & Commentary*

# Corrective Actions Check List

## Corrective Action & Verify Check List

Yes No

Has corrective action been established?		
Does it meet the required givens?		
Have different alternatives been examined as possible corrective actions?		
Have Poke-Yoke techniques been considered?		
Has each alternative been screened?		
Have the risks involved with the corrective action been considered?		
Was the corrective action verified?		
Was the corrective action proven to eliminate the root cause?		

*Notes & Commentary*

# D6

## Implement Permanent Corrective Actions

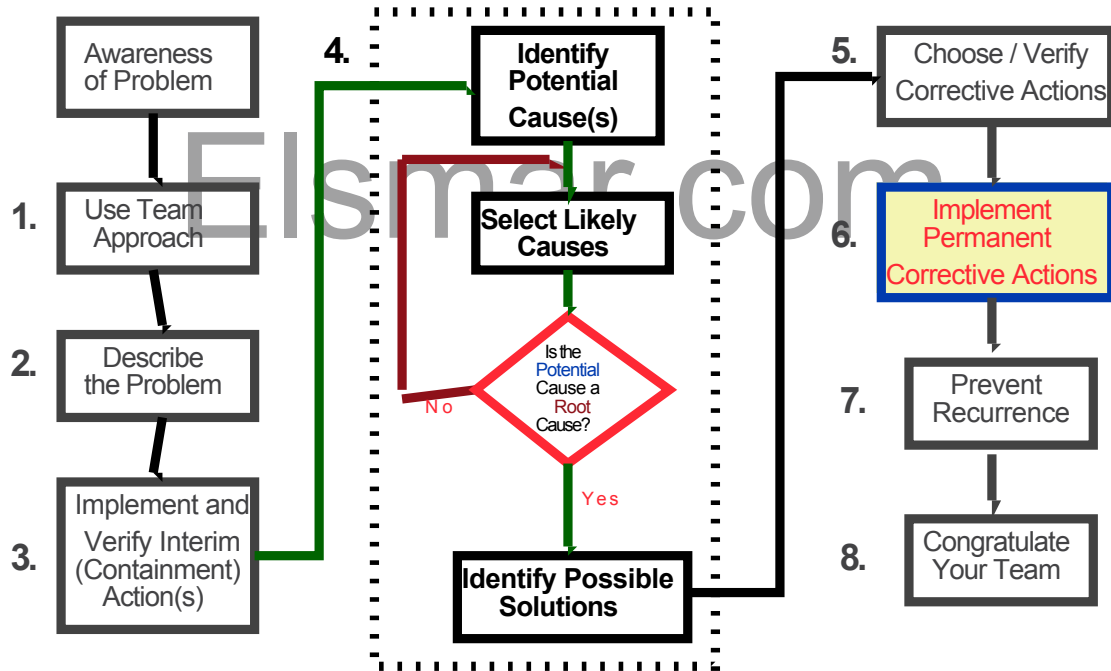
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*Notes & Commentary*

# Implement Permanent CA Objective

## Objective

Define and implement the best permanent corrective actions. Choose on-going controls to ensure the root cause is eliminated. Once in production, monitor the long-term effects and implement contingency actions, if necessary.

## Identify Alternative Solutions

- Evaluate how other groups solved similar problems.
- Use brainstorming to generate Alternate Solution C&E diagram.
- Consider redesign of the part or process to eliminate the problem.
- Anticipate failure of the solution. Develop contingency action(s).

## Implement Solution

- Use an action plan approach to implement the solution.
- Test and verify contingency actions, if possible.

*Notes & Commentary*

## Implement Permanent Corrective Actions

- Define and implement the 'appropriate' corrective action(s).
- Choose on-going controls to ensure the root cause is eliminated.
- Once in production, monitor the long term effects and implement contingency actions (if necessary).

*Notes & Commentary*

## Implement Permanent Corrective Actions

- Once the root cause(s) have been identified, the team establishes an action plan on the permanent actions to be taken. Again, the action plan includes **who** will do **what** by **when**. The permanent actions are implemented to solve the problem. The question "Why did this occur?" must be answered.
- Establish ongoing controls on the process to ensure the process remains in control. Once the permanent corrective actions are in place, the ongoing controls will verify the effects of the actions.
- To forecast reduction of the problem, indicators such as scrap reports, etc., can be used. A statistical plan will verify the effectiveness of the actions. A systematic approach involves a plan to establish the facts using data or evidence as a requirement for making decisions. Data is obtained by investigations and experiments to test assumptions. These assumptions are identified by translating the customer concerns into understandable definitions of what the problem is and relating these definitions of the problem to product and processes. These definitions and data are used to verify solutions.

*Notes & Commentary*

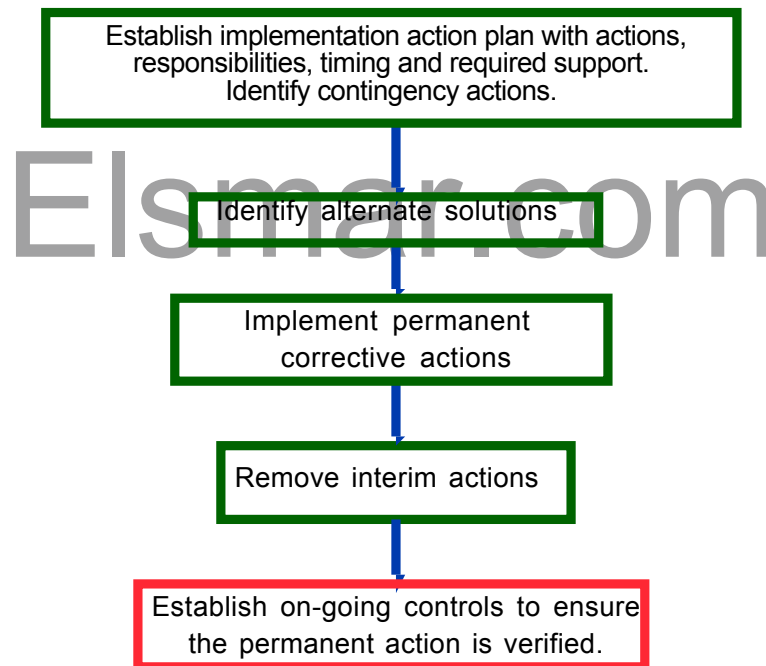


## Implement Permanent Corrective Actions

- Once permanent solutions are in place, document the changes. In addition, all customers need to be informed about what actions were taken. In most cases, some type of training is required to institute permanent corrective actions. Training may be required to implement a product design or process change. In addition, implementation of the permanent actions may need to include the effect on design or process issues. In manufacturing, maintenance personnel often need to be informed of the changes.
- Another important part is to correct the obvious. This includes correcting defective parts already produced, changing product design, changing tooling, reworking defective machines and/or equipment, revising ineffective operating systems or working with and/or replacing suppliers.
- Contingency actions should be identified if for some reason the permanent actions cannot be implemented. For example, in manufacturing a recommendation to single source a part may be recommended. But, if one vendor is unable to meet the increased productivity alternate action is necessary. Contingency actions based upon risk assessment are essential to the success of permanent corrective actions for customer protection and problem solution.

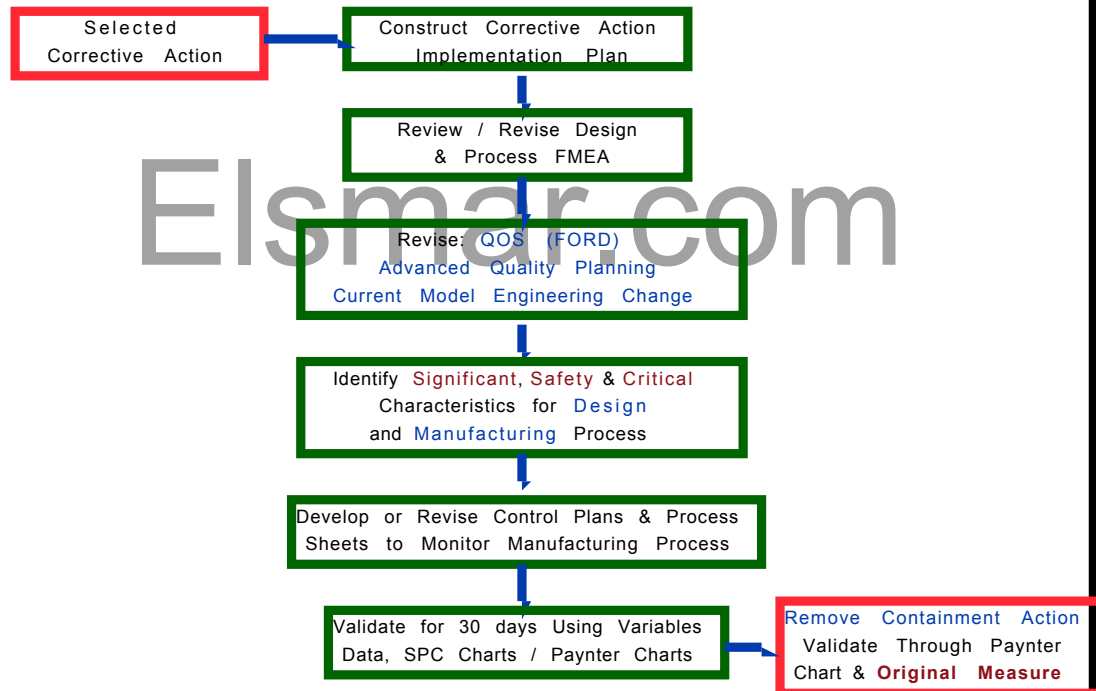
*Notes & Commentary*

## Implement Permanent Corrective Actions Flow



*Notes & Commentary*

## Implement Permanent Corrective Actions Flow



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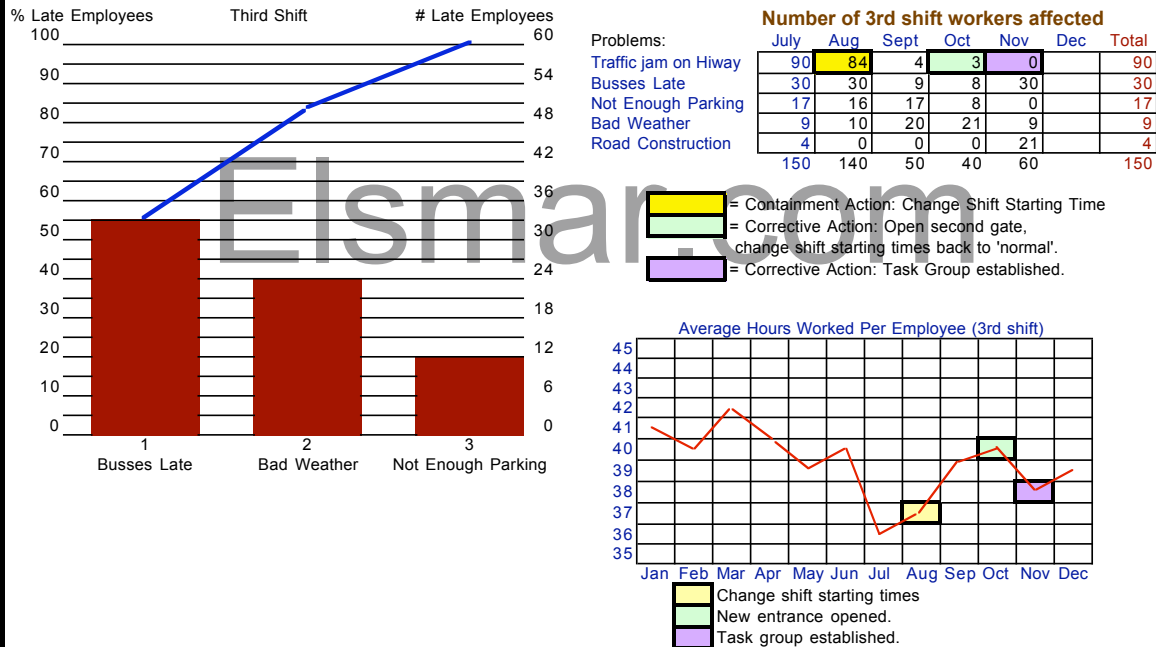
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*Notes & Commentary*

# Validation Evidence



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*Notes & Commentary*

## Corrective Action Questions

- Do the actions represent the best possible long-term solution from the customer's viewpoint?
- Do the actions make sense in relation to the cycle plan for the products?
- Has an action plan been defined?
  - △ Have responsibilities been assigned?
  - △ Has timing been established?
  - △ Has required support been defined?
  - △ What indicators will be used to verify the outcome of the actions, both short-term and long-term?

*Notes & Commentary*

# Ongoing Controls - Questions

## Ongoing Controls

- Ensure the problem will not reoccur.
- Seek to eliminate inspection-based controls.
- Address 5M sources of variation.
- Test the control system by simulating the problem

## Questions

- Have the corrective action plans been coordinated with customers?
- What indicators will be used to determine the outcome of the actions?
- What controls are in place to assure the permanent fix is verified as intended?

*Notes & Commentary*

## Forecast Outcome

- Will actions permanently solve the problem?  
Can you try out the corrective actions on a small scale to test effectiveness?
- Can scientific experiments be conducted to gain knowledge to predict the outcome of the effects of the implemented actions?
- Do the permanent corrective actions require support from external sources to be effective?

*Notes & Commentary*

## Implement CA and Verify Over Time Check List

Implement CA & Validate Over Time	Yes	No
Has the implementation plan been constructed to reflect Product Development Process events and engineering change process?		
Do the corrective actions make sense in relation to the cycle plan for the products?		
Have both Design and Process FMEAs been reviewed and revised as required?		
Have significant / safety / critical characteristics been reviewed and identified for variable data analysis?		
Do control plans include a reaction plan?		
Is simultaneous engineering used to develop process sheets and implement manufacturing change?		
Is the Paynter Chart in place for validating data?		

*Notes & Commentary*



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## Prevent Recurrence

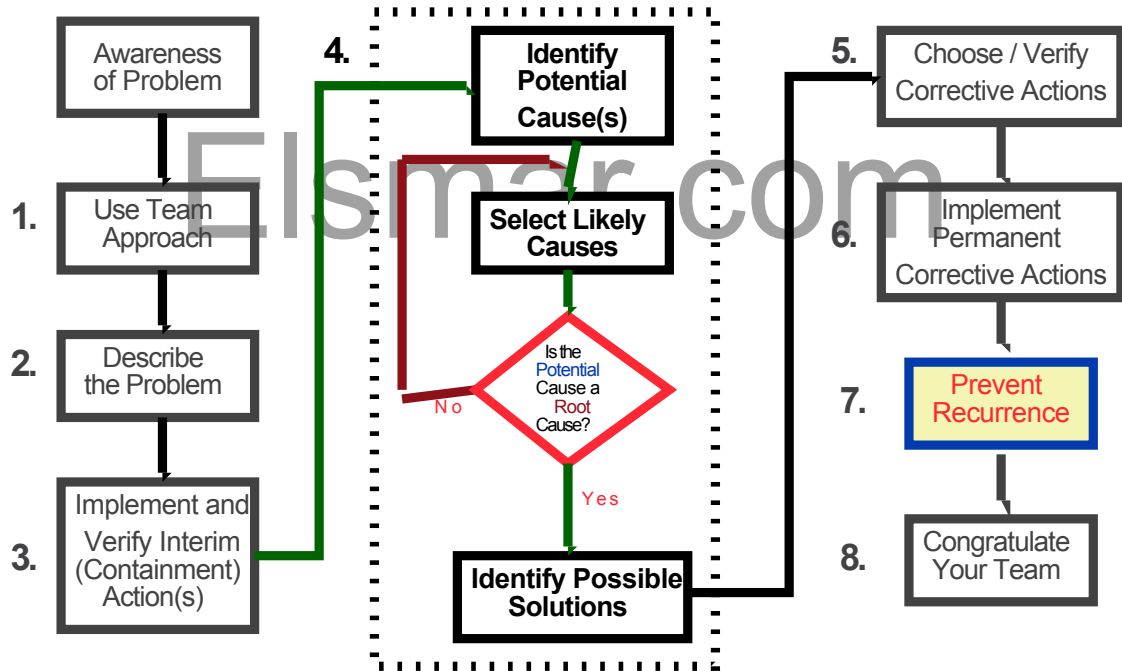
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*Notes & Commentary*

## Prevent Recurrence Objective

Modify those management systems, operating systems, practices and procedures to prevent recurrence of this problem and all similar problems.

- Prepare a process flow diagram of the management / operating system that should have prevented the problem and all similar problems.
- Make needed changes to the system. Address system follow-up responsibilities.
- Standardize practices.
- Use action plan to coordinate required actions.

*Notes & Commentary*

## Prevent Recurrence

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**Modify the management systems,  
operating systems, practices, and  
procedures to prevent recurrence of this  
and all similar problems.**

*Notes & Commentary*

# Prevent Recurrence

- ∞ This next step in the Problem-Solving Process is the seventh step. It is important to understand what in the process allowed the problem to occur. A **cause-and-effect diagram** can be used to outline the reasons the problem occurred. By asking "Because?" the C&E diagram can be constructed.
- ∞ Another effective tool is a process flow diagram. The process flow of the manufacturing or engineering process can be effective in identifying where in the process the problem could have been prevented. To prevent recurrence of the problem, most of the time a change to the management system will be required. Managers must understand why their system allowed a problem develop. The same system will allow future problems to occur.

*Notes & Commentary*

## Prevent Recurrence

- △ Management systems, practices and procedures need to be fully understood to be effective. Most of them are carry-overs from previous model years and organized structures. Some are outdated and need to be revised. Understanding the elements of a management system can be achieved by maintaining an up-to-date flow diagram of the system and process. Also, there should be easy to follow instructions for those who are part of the system.
- △ Management systems, practices and procedures should provide management support for 'Never ending improvement' in all areas and activities. The system should encourage individuals to participate freely in the problem solving process. It should help to understand more about their job and how each individual's effort affects the outcome of the final product on customer satisfaction. The system should encourage everyone to learn something new. And it should recognize individual and team effort when these new skills are applied.

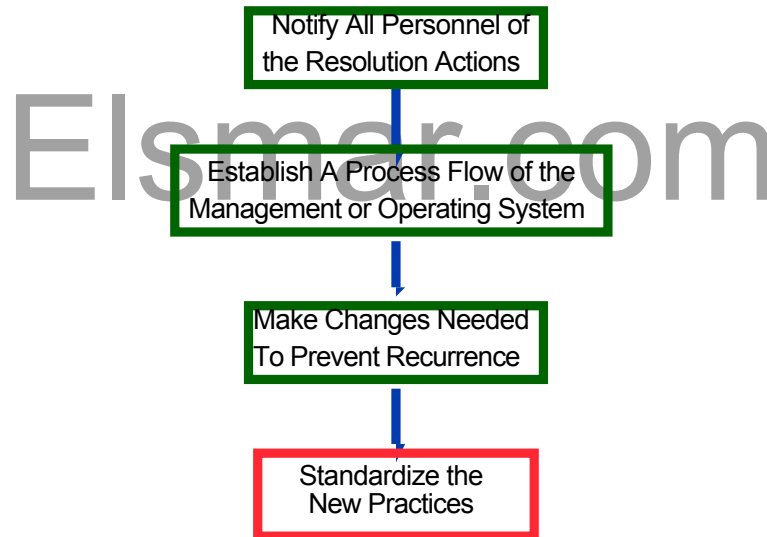
*Notes & Commentary*

# Prevent Recurrence

- △ Changes in the management system can require documenting new standard procedures, streamlining to remove obsolete procedures and revising previous standards. Changes in the management system need to be communicated clearly to all customers.
- △ To prevent recurrence additional training is often required. Training may be needed in statistical techniques and methodologies, new engineering or manufacturing technologies or disciplines, better process and/or project management.
- △ If concerns develop regarding changes to the system, these issues will be addressed. A new team may need to be assigned with the authority to address the management system.

*Notes & Commentary*

# Prevent Recurrence Flow



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*Notes & Commentary*



## Prevent Recurrence Questions

- Have all affected personnel been notified of the resolution actions?
- Has a process flow of the management system which will prevent this and similar problems in the future been prepared?
- Have the practices been standardized?
- Have action plans been written to coordinate actions?
- Have changes been made to the appropriate systems?
- Has the problem occurred due to a **behavioral** system?

*Notes & Commentary*

# Prevent System Problems Check List

## Prevent System Problems Check List

Yes No

Have the system prevention practices, procedures & specification standards that allowed the problem to occur and escape been identified?		
Has a champion for system prevention practices been identified?		
Does the team have the cross-functional expertise to implement the solution?		
Has a person been identified who is responsible for implementing the system preventive action?		
Does the system preventive action address a large scale process in a business, manufacturing or engineering system?		
Does the system preventive action match root cause (occur & escape) of the system failure?		
Does the team utilize error proofing and successive checks on a proactive on-going basis to eliminate the occurrence and escape of all defects?		
Has a pieces over time (Paynter Chart) been used to indicate that the system preventive actions are working?		
Has the System Preventive Action been linked to the Product Development phase?		

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## Congratulate Your Team

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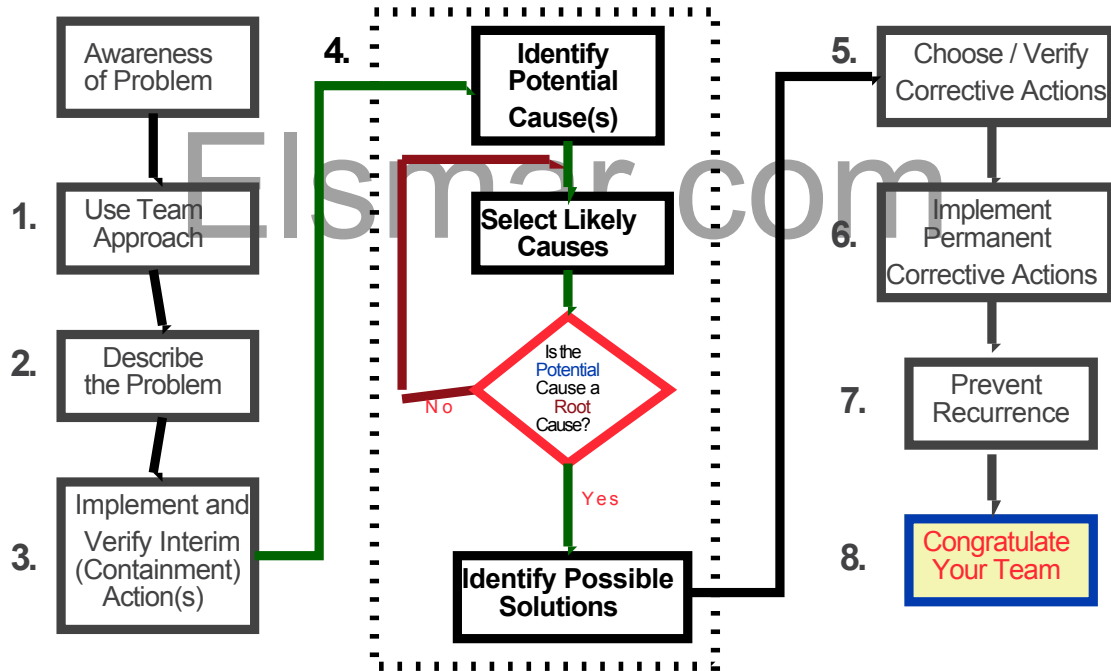
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### Notes & Commentary

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*Notes & Commentary*

# Congratulate the Team

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**Recognize the collective efforts  
of the team.**

*Notes & Commentary*

# Congratulate Your Team

The final step in a team oriented problem solving effort is to recognize the team's collective efforts in solving the problem and show gratitude by applauding individual contributions. Management will need to determine the best way to recognize the team's contribution to the origination. In addition, individual effort and talents need to be highlighted and rewarded.

Team oriented problem solving involves risk taking, some conflict, hard work and participation by everyone. It includes a free exchange of ideas,, individual talent, skill, experience and leadership. The team approach, when led effectively, produces a driving force of individuals motivated and committed to solving a specific problem.

*Notes & Commentary*

# Congratulate Your Team

The form of recognition can vary, depending upon the complexity and severity of the problem. It is important to document what was learned while solving the problem so that this information can be used by others for planning. A description of the various actions carried out, together with the analysis and results obtained through the problem solving process, provide information that can be used to prepare a case study report. Case study reports include the purpose and objective, the procedure or problem solving steps followed, the data obtained through various investigative methodologies and the analysis of data in the form of results shown by charts and graphs, conclusions and recommendations.

This final step in the problem solving process is to conclude the successful efforts of the team is to acknowledge the significance and value, in quantifiable terms, of solving the problem for the customer and for improving quality and productivity for the company.

*Notes & Commentary*

# Congratulate Your Team Flow

Determine the Appropriate Recognition  
for All Active, Participating Team Members



Document and Communicate  
The Efforts of The Team

*Notes & Commentary*



## Congratulate Your Team Objective & Questions

### Objective

Recognize the collective efforts of the team.

### Questions

- Have creative solutions been taken to warrant a review for a company sponsored award?
- has appreciation been shown to all the team members that contributed to the first 7-D's?
- How has the team leader identified each individual's contribution to the problem resolution?
- Was the problem and solution documented and communicated?

*Notes & Commentary*

# Congratulate Your Team Check List

## Congratulate The Team Check List

	Yes	No
Have documented actions and lessons learned been linked to Product Development Process for future generations of products?		
Has appropriate recognition for the team been determined?		
Has application for patents & awards been considered?		
Has team been reassessed?		
Has the team analyzed data for next largest opportunity?		

*Notes & Commentary*