

TURNAROUND
TIME:

ELEVATE YOUR
COMPANY USING
LEAN & SIX SIGMA

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AGENDA

1. Lean

1. Origins
2. Methodology
3. 8 Wastes – DOWNTIME
4. Creating and Optimizing your Value Stream
5. Lean project results

2. Six Sigma

1. Origins
2. Methodology & Structure
3. DMAIC model for problem solving
4. Practical Tools
5. Six Sigma project results

Questions & Answers

CONFORMITY



- He is conforming
- He is NOT being efficient

Lean methodology is a customer-focused management approach that aims to:

- **Optimize workflows,**
 - **Reduce unnecessary steps, and**
 - **Improve overall efficiency**
- while maintaining high quality and customer satisfaction**

A person in a blue suit is holding a glowing blue sphere with the word "LEAN" in white capital letters. The sphere is surrounded by a network of blue lines and dots, suggesting a complex system or process. The background is dark with a faint grid pattern.

LEAN

ORIGINS OF LEAN - DEMING

- In 1947, **W. Edwards Deming**, American statistician, went to Japan to help enhance their production processes. He stressed that quality should be prioritized at every stage of production, achieved through statistical process control. Deming is particularly recognized for his PDCA Cycle – Plan, Do, Check, Act - which advises stopping production when deviations occur to identify and resolve issues before continuing. During his time in Japan, he trained hundreds of engineers, managers and executives in his approach.^[8]
- Deming developed his concepts into what he termed "total quality management," which eventually laid the groundwork for Toyota's Toyota Production System focused on just-in-time manufacturing.
- Deming published many best-selling books including

Out of the Crisis and **14 Points for Management**

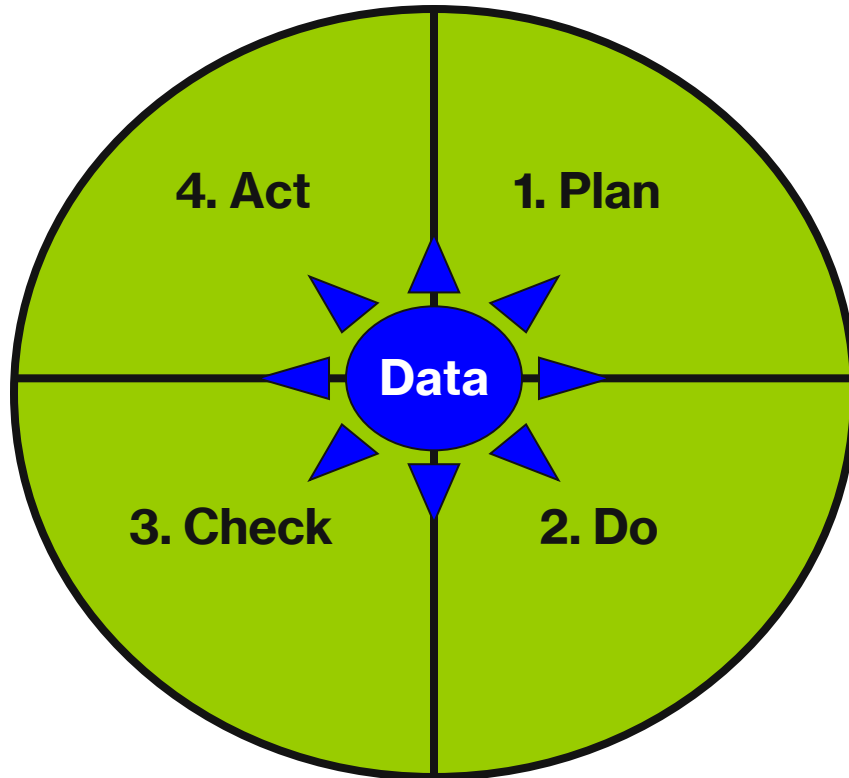


W. Edwards Deming
1900-1993

DEMING INTERVIEW 1984

https://youtu.be/0yGhR1ybmN8?si=d3y3Ho_VrBMXOkIM

Plan/Do/Check/Act



- **Plan** - what could be the most important team accomplishment?
- **Do** - carry out the change or test decided upon, preferably small scale
- **Check** - Observe or study the effects.
- **Act** - from what we learned from the results, implement improvements if needed for both internal and external customers.

The Shewart or Deming Cycle

ORIGINS OF LEAN - TPS

- **Toyota Production System (TPS)** - originally called Just-in-time (JIT) production
- Toyota founder Sakichi Toyoda, his son Kiichiro Toyoda, and Taiichi Ohno Industrial Engineer came to US and studies 2 industries:
 1. Henry Ford's auto assembly line at River Rouge in Dearborn, MI
 2. Supermarkets - Kanban
- Taiichi Ohno is considered the father of Lean and the architect of TPS.
- He authored several books on Lean including:

Toyota Production System: Beyond Large Scale Production, Just-in-time for Today and Tomorrow, and Taiichi Ohno's Workplace Management



Taiichi Ohno
1912-1990

HOW WE GOT HERE...

- In 1950 Japanese business leaders invited Deming to Japan to teach executives and engineers about the new methods. Japanese companies quickly adopted his methods, with the result being a commitment to quality control that helped Japanese firms dominate some product markets in many parts of the world. The Deming Prize (established 1951), awarded annually to Japanese corporations that win a rigorous quality-control competition, is named in Deming's honor. It was not until the 1980s that Deming's ideas were adopted by American corporations seeking to compete more effectively in the world market.
- TPS has since become widely recognized as the standard in Lean Thinking

Lean Methodology

We will explore a few key tenets of Lean

- **Elimination of MUDA (waste)** throughout all business processes
- **5-S:** Organizing the workplace to reduce motion waste and improve safety as well as efficiency.
- **Value Stream Mapping:** a Shewart high-level flowchart that visualizes every step in the production process, from raw material to finished product, differentiating value-adding steps from non-value-adding ones.

ELIMINATE WASTE

- Originally 7 wastes using the acronym TIMWOOD by Taiichi Ohno



DOWNTIME – 8 WASTES

- Now we use DOWNTIME, which adds an eighth: Non-utilized talent

DEFECTS



OVERPRODUCTION



WAITING



NON-UTILIZED POTENTIAL



TRANSPORT



INVENTORY



MOTION



EXTRA PROCESSING





DEFECTS: Often the most visible waste

- In distribution, manufacturing, or repair, a defect is any process, component/part/assembly OR associated paperwork that is non-conforming to:
 - Your company's Quality Management System and operational processes
 - Your QMS standard ASA-100/ISO9001/AS9100/AS9110/AS9120, or
 - Your customers' requirements
- An Auditor's Observation: very limited use of Corrective Action Process.
 - Are you writing Corrective Action Reports (CARs) against your own Internal Audits?
 - If you are not finding Non-Conformances and your external auditors are: are you sampling your records as objective evidence, or just stating where your process is described in your quality manual?
 - Are you tracking all errors, identifying root cause, and holding offenders accountable? For part AND paperwork errors?
 - Supplier A has had 10 documentation errors in the past 6 months, but it's quicker to fix it and move on.
 - YOU GET WHAT YOU EXPECT, AND YOU DESERVE WHAT YOU TOLERATE.



OVERPRODUCTION

- In manufacturing: Producing and storing more than you can sell consumes space and potentially leads to scrapping good product.
- Solution: Move from push to pull system

WAITING: the silent productivity killer – often unmeasured



- Causes: machine downtime, material shortages, bottlenecks in production/repair processes.
- Does your process rely on batch processing vs one-piece- flow?
- Are their hand-offs between functions that can be minimized or eliminated?
 - Could employees be cross-trained to perform multiple functions?



NON-UTILIZED POTENTIAL

- Example: An employee is experienced in his process but not involved in problem-solving or continuous improvement to offer his expertise.
- Proper cross-training to maintain efficient use of everyone's time and talents?
 - Need to convert tribal knowledge to best practices
 - Do you have backups for knowledge and clear direction for each critical operation?
- Multiple employees trained for Internal Audits (not just Quality) to ensure independent/unbiased evaluation of all functions?
 - Lessens the burden on IA team, improves business knowledge of new auditors
- Career development path for employees to ensure:
 - Business continuity/strategic objectives are being met
 - Personal growth and job satisfaction

TRANSPORTATION



Unnecessary movement of materials, tools, or finished goods

- Is your facility optimized for flow?
 - Take a video of material from receipt to shipping.
 - Are your receiving and shipping processes reliant on external resources?
 - Are there constraints that could be adjusted to improve efficiency?

INVENTORY



Supply in excess of what is required to meet customer demand

- May apply to raw materials, work-in-progress (WIP), and finished goods
- While Just-in-Time strategy works well for manufacturing, distribution may require a different approach.
 - Evaluate cost of storage and preservation vs customer demand
 - Advantage of large inventory: if you need it, we have it. Our stakeholders value our business based on the value of our inventory.
 - Disadvantage: capital cost of warehouse space and increased potential for obsolescence
 - Advantage of limited inventory (brokering)- we sell before we buy, quick turnaround. Minimal storage space required.
 - Other variations when dealing with repair shops and consignment partners.

MOTION



Any movement of people or equipment that does not add value.

- Includes reaching, bending, walking, and repetitive motion
- Are supplies and tools properly arranged to facilitate employee ergonomics and workflow?
 - Evaluate work areas for safety and ergonomics
 - Map out employee motion and travel throughout a shift.



EXTRA PROCESSING

Performing more work than is required by the customer

- Test and Inspection: May be required by customer or by regulation, but do not add value.
- **TO BE CLEAR: NEVER CIRCUMVENT REGULATORY OR CUSTOMER REQUIREMENTS!**
- Avoid the tendency to add additional test/inspection steps as a corrective action unless they will eliminate the root cause, and monitor the solution over time for effectiveness (**Control** – the C in DMAIC).
- See Required Waste

KAIZEN

- **Kaizen:** the concept that significant positive results can be achieved due to the cumulative effect of many (often small) improvements to all aspects of a company's operations.
- While often applied to the production environment, Kaizen concepts can be applied to any business process throughout the value stream.
- One of the most common applications is the 5-S methodology.



5-S

Organizing the workplace to reduce motion waste and improve safety as well as efficiency.

- **Seiri (整理) – Sort:** Remove unnecessary items from the workspace and keep only what is needed
- **Seiton (整頓) – Set in Order:** Arrange necessary items so that they are easy to access and each item has a designated place.
- **Seisō (清掃) – Shine:** Clean the workspace, tools, and equipment to maintain a tidy and functional environment.
- **Seiketsu (清潔) – Standardize:** Establish standards for organization and cleanliness to maintain consistency across the workplace.
- **Shitsuke (躰) – Sustain:** Develop discipline and habits to ensure that the 5S practices are followed continuously.

TAKT TIME

- The term “**Takt**” is of German origin, meaning rhythm, cadence, or cycle, and was initially used in music to indicate timing.
- After World War II, **Toyota** sought to improve production efficiency with limited resources. Engineers recruited from the aircraft industry, along with **Taiichi Ohno**, adapted takt time to the **Toyota Production System (TPS)** in the 1950s.
- Ohno emphasized that takt time represents the **time required to produce one unit to meet customer demand.**

Takt Time= Available Production / Customer Demand

Example: 8hours of production -2 15min breaks and 30 min lunch

420 minutes

Customer demand: **210** units/shift

Takt Time= 2 minutes per unit

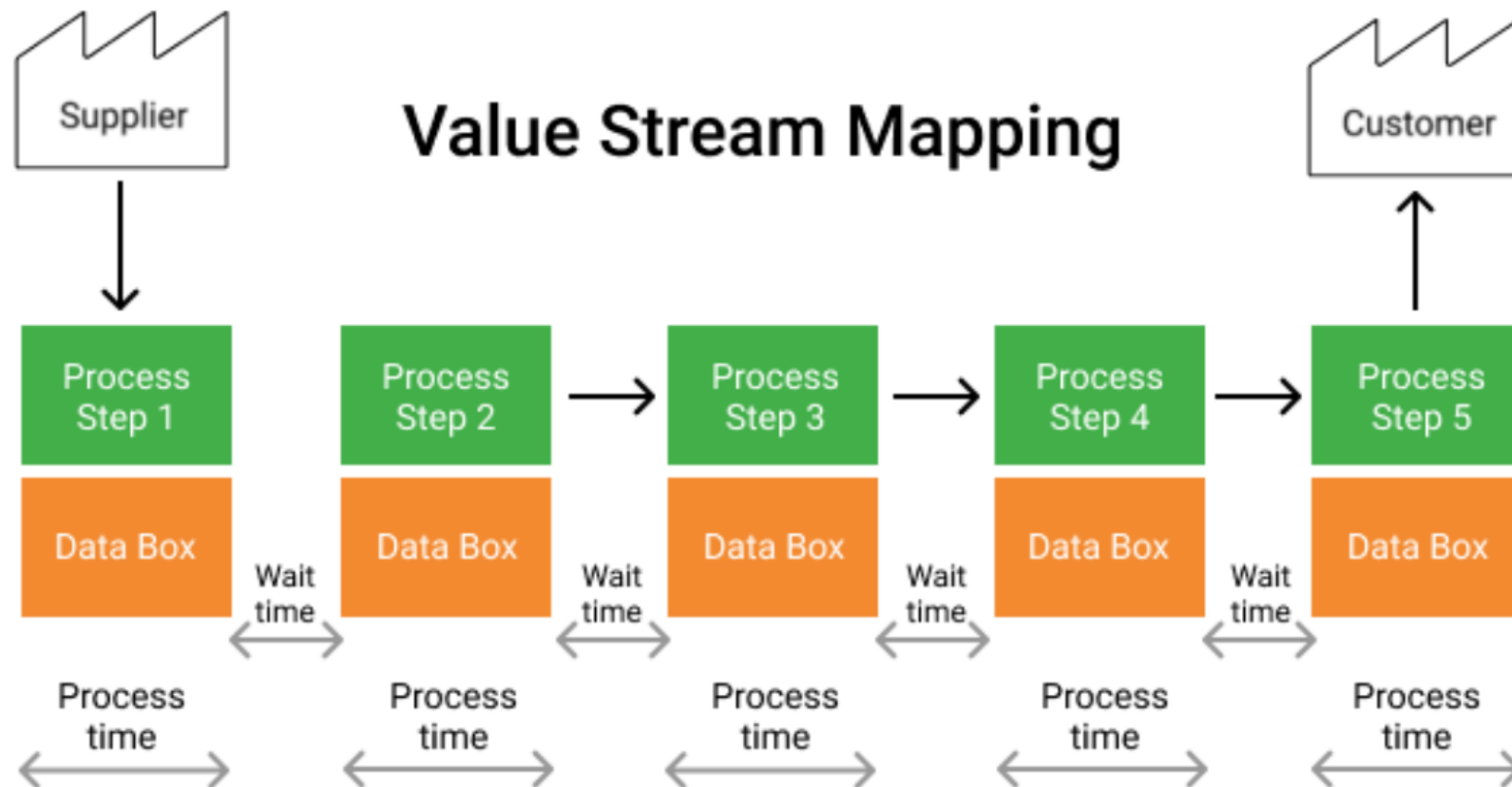


IT'S ALL ABOUT FLOW

- Balance line to takt time to reduce bottlenecks
- What if you have a batch process?
 - Example: parts require heating in oven
 - Establish a standard Work-In-Progress (WIP) queue in front of the oven
 - Minimizes downstream wait time
- OR, could I eliminate a batch process?
 - Convert to one-piece flow
 - Conveyor for pizza vs oven (batch process)

VALUE STREAM MAPPING

- A high-level flowchart that visualizes every step in the production or service process, from raw material to finished product, differentiating value-adding steps from non-value-adding ones.



VALUE – what my customer is willing to pay for

- All labor can be placed into one of three categories:
 - **Value Added** – converting materials and information into finished product/services
 - **Required Waste** – necessary for regulatory or customer requirements, but doesn't add value (e.g., test and inspection)
 - **Pure Waste** – no value

STEPS TO OPTIMIZE VALUE

1. Measure current state

- Identify how much time & distance is required for each process and operator
- Video is better than a stopwatch; allows detailed analysis and not reliant on your memory
- Categorize each process step as value-added, required waste, or pure waste

2. Develop future state map (draft)

3. Eliminate all pure waste

4. Minimize/optimize required waste

- if 2 tests are strongly correlated, consider eliminating one
- If process is in control over long term, reduce sampling or remove test/inspection (without violating regulations!) – see Six Sigma topic on Control Charts

5. Streamline Value Added activities

6. Confirm Future state map, monitor process, and continuously improve

EXERCISE

- Which process in your business is not running as efficiently as you would like?
- Can you think of any examples of pure waste that could be easily eliminated?
- Are there tests or inspections that are not required by regulatory or customer requirements?

Lean results – Cordis Corporation, Miami FL

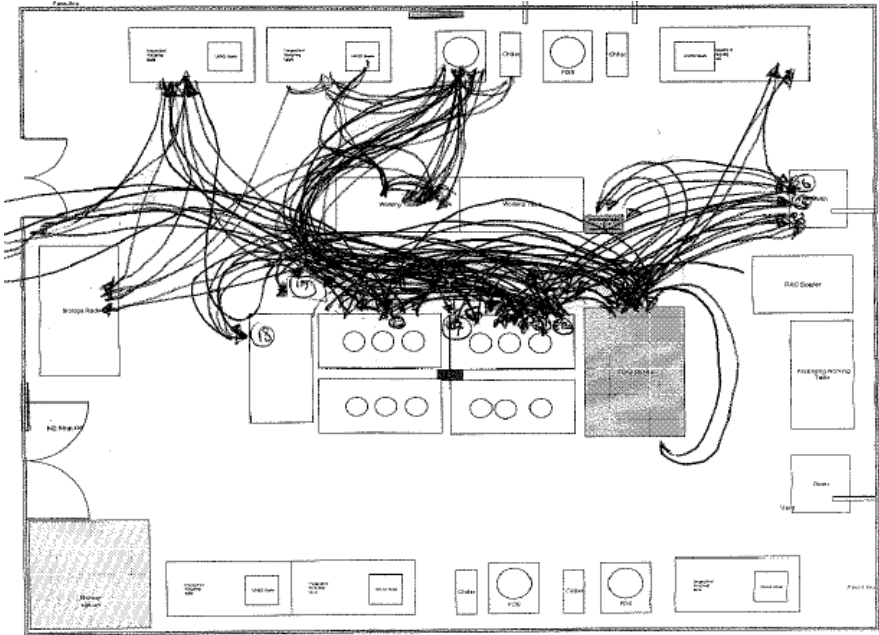
- 2003 Cordis sister plant in San German, Puerto Rico
 - Worked with Lean consulting group
 - Optimized processing of Cypher stents in clean room environment

2003-2004 Cordis Miami Lakes, FL

- Optimized catheter production
- Converted from batch processing to one-piece-flow

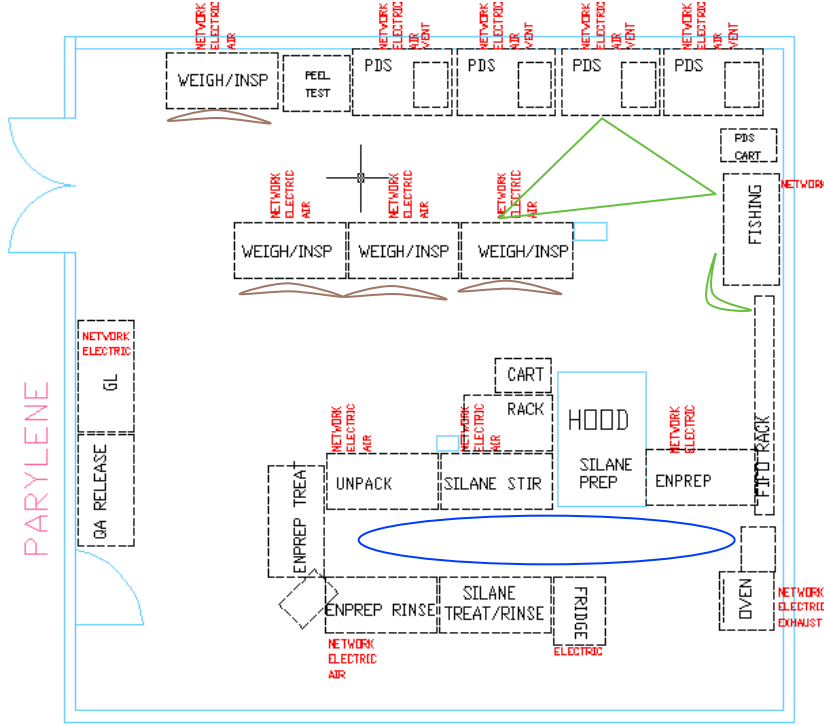
Labor flow – before and after

BASE



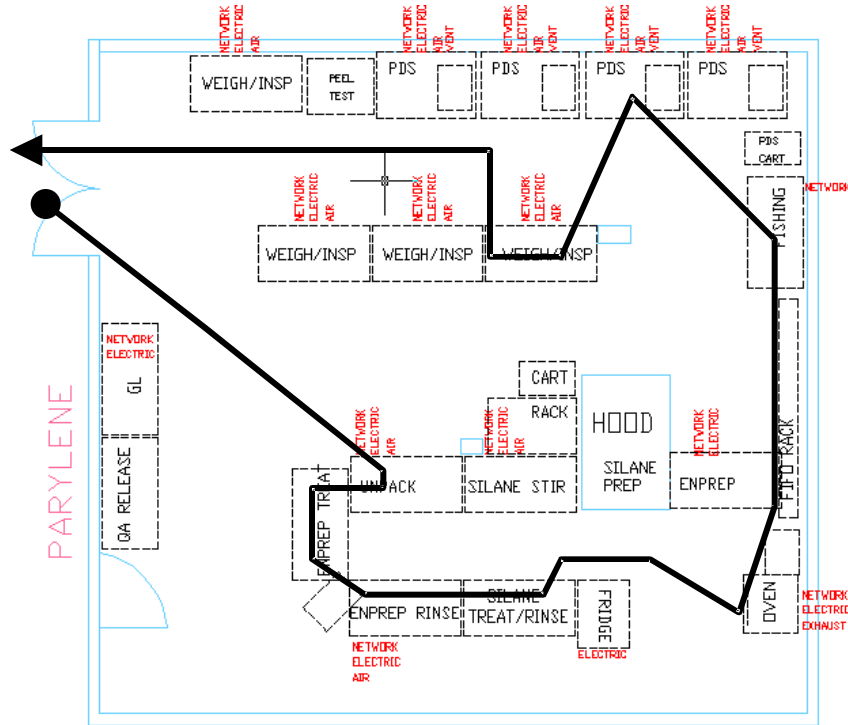
16 operators

LEAN

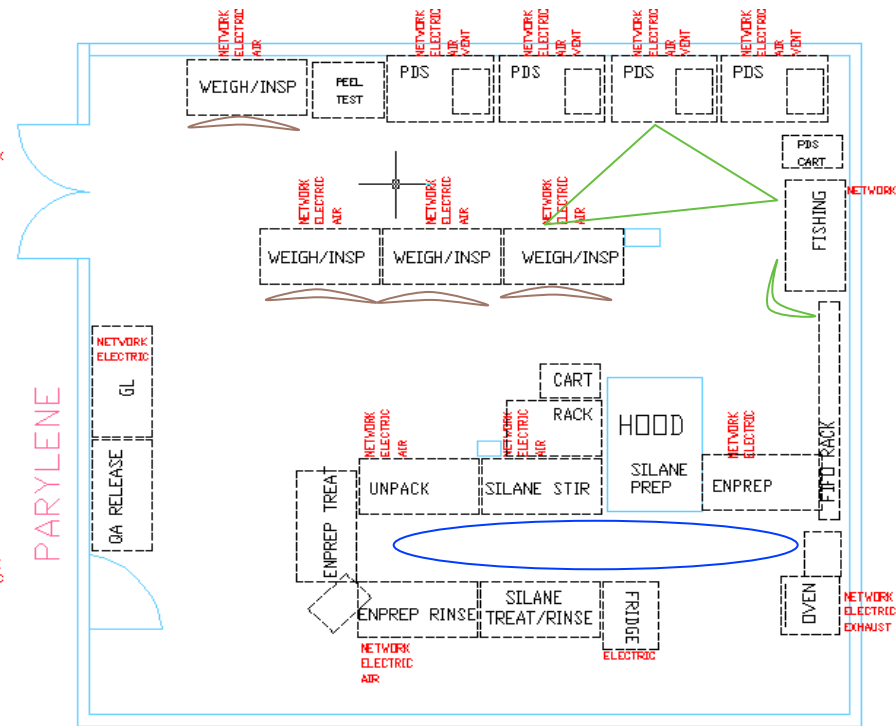


7 operators

Final Product flow



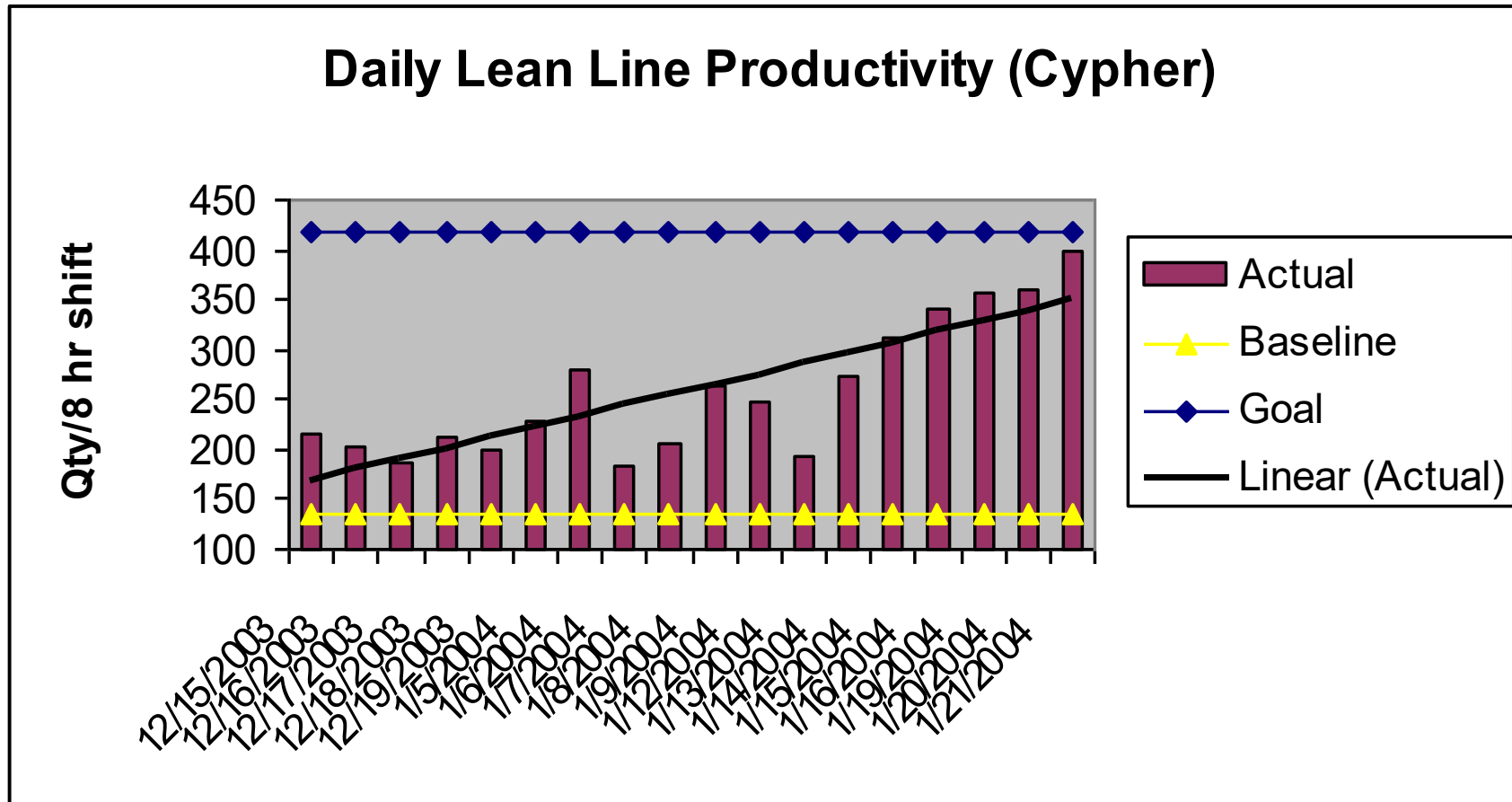
Final labor flow



Results

- Reduce labor headcount from 16 to 7/shift
- Increase stent output from 8 lots to 12 lots/day
- Reduced cycle time from 13 hours to 4 hours
- Estimated annualized cost savings - \$300K

Productivity Trend – Miami catheter assembly



RESULTS: MIAMI PTCA/SDS

	Base	Lean (current)	% Improvement	Lean (Goal)
Throughput	5903 min	15.6 min	99.74%	12.24 min
Cycle Time	Unknown	1.30 min	N/A	1.02 min
Direct Labor	17/line	13/line	24% (55% total)	13/line (84 total)
Travel Distance	1667 feet	580 feet	65.21%	550 feet
Output/Hr	19	51	268%	59

Total Annual Savings = \$2.5 million.

Represents 20% of the PTCA/SDS 2004 budget.

SIX SIGMA

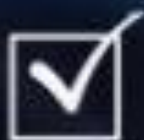
DEFINE

MEASURE

ANALYZE

IMPROVE

CONTROL



ORIGINS OF SIX SIGMA (6σ)

- **Six Sigma (6σ)** is a set of techniques and tools for process improvement. It was introduced by American engineer Bill Smith while working at Motorola in 1986.^{[1][2]}
- Six Sigma strategies seek to improve manufacturing quality by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes. This is done by using empirical and statistical quality management methods and by hiring people who serve as Six Sigma experts. Each Six Sigma project follows a defined methodology and has specific value targets, such as reducing pollution or increasing customer satisfaction.

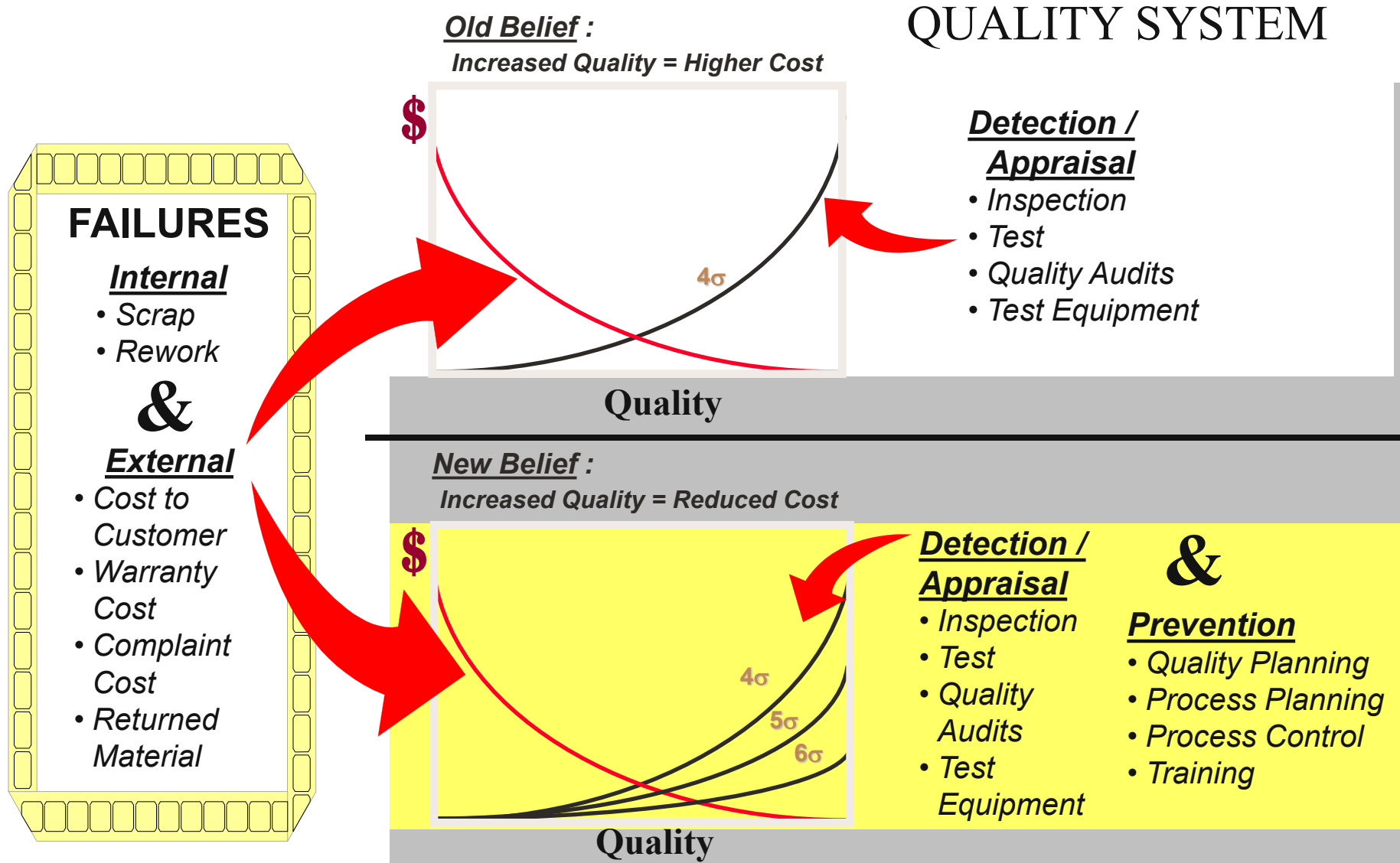


MOTOROLA'S SIX SIGMA INITIATIVE

“Six Sigma” is a business initiative “aimed at the near-elimination of defects from every product, process and transaction”

“Six Sigma technically means having no more than **3.4 Defects Per Million Opportunities** in any product process or service. It’s a disciplined, quantitative approach for improvement of defined metrics in, for example, product/process design, manufacturing, service areas (e.g. financial processes) research and development, etc

THE COST OF QUALITY



Six Sigma Project Team

Role	Description
Project Champion	Process owner – connection between management and team; drafts project charter
Black Belt/Leader	Full or part-time expert leading project execution and problem solving
Green Belt	Assist the leader, manage task completion, typically part-time on project
Subject Matter Expert –as needed	Specialized expert providing technical knowledge as required
Master Black Belt	Advanced coaching, proficient in complex tools and methods
Sponsor	High-level executive to remove barriers and allocate resources

Scalable to the size of company and scope of project

Green Belt and Black Belt Curriculum

1. Green Belt and Black Belt Skill Requirements plus Demonstration of Skills.

Select technical & interpersonal electives, and check completed skills & demonstrations:

	Green Belt		Black Belt		
	Skill	Demo	Skill	Demo1	Demo2
Core Requirements					
Introduction to the Black Belt Program	☒				
Six Steps to Six Sigma Concepts	☒				
Continuous Improvement	☒				
Quality System Overview	☒				
Process Characterization Concepts	☒				
Benchmarking Concepts	☒				
Quality Function Deployment (QFD) Concepts	☒				
Basic Statistics	☒				
Problem Solving	☒	☒		☒	
Comparative Methods	☒	☒		☒	
Leadership (Black Belt Only)			☒	☒	
Technical Skills Requirements					
1- Failure Modes and Effects Analysis (FMEA)	☒	☒		☒	☒
2- Process Capability and Control (SPC)	☒	☒		☒	☒
3- Reliability and Availability			☒	☒	☒
4- Nonparametric Statistics			☒	☒	☒
Interpersonal Skills Requirements					
1- Project Management			☒	☒	
2- Teamwork			☒	☒	

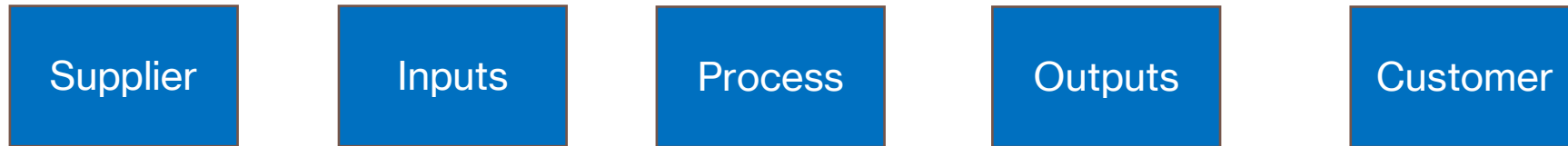
- Combination of training and demonstrated use of tools required to become certified
- Each Green Belt and Black Belt is assigned a mentor (may be external)
- Completed project charter reviewed by management

Six Sigma Project Charter

<i>Team Leader</i>		<i>Date</i>	
<i>Mentor</i>		<i>Product/Service Impacted</i>	
<i>Sponsor</i>			

Element	Description	Specifications				
1. Process	Name of process to be improved.					
2. Problem Statement	What practical problem will be solved? What is project's purpose?					
3. Objective	What metrics will be improved, what is the current performance for those metrics and how much improvement is targeted? Provide specifics on how metrics are computed.	Metrics	Current	GOAL	% Improve.	units
		Metric 1				
		Metric 2				
		Metric 3				
4. Process Scope	Which process steps will be considered in this project?					
5. Business Case	Justification for this project. Why is it important? Estimate Return On Investment (ROI)					
6. Benefit to Internal and External Customers	How will internal or external customers benefit from this project?					
7. Team members	Names and roles of team members.					
8. Schedule Milestones	Define					
	Measure					
	Analyze					
	Improve					
	Control					
9. Support Required	What resources, people, departments are required?					
Green Belt Candidate	Print					Sign
Project Sponsor	Print					Sign
Mentor	Tony Cafarchio, MBB					

SIPOC



Who supplies your inputs (upstream)?
May be internal or external

What are the key inputs to your process?

- Materials
- Tools
- Data
- Procedures
- WIP

Start here:
What are the basic steps of your process?
Use a process flow diagram

What are the key outputs to your process?

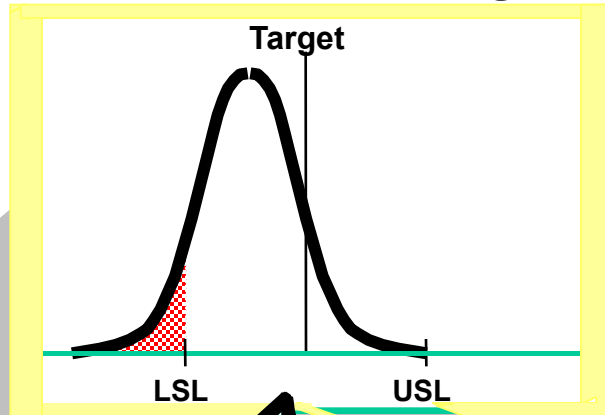
- WIP
- Data
- Records

Who is/are the downstream recipient(s) of your process output?
May be internal or external

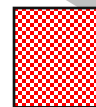
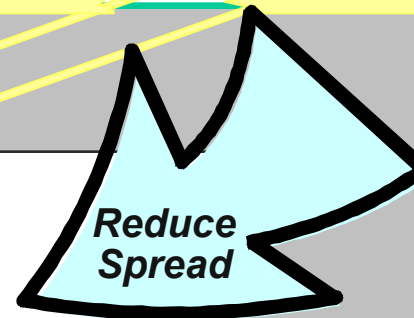
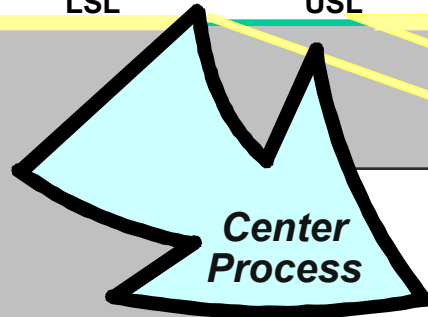
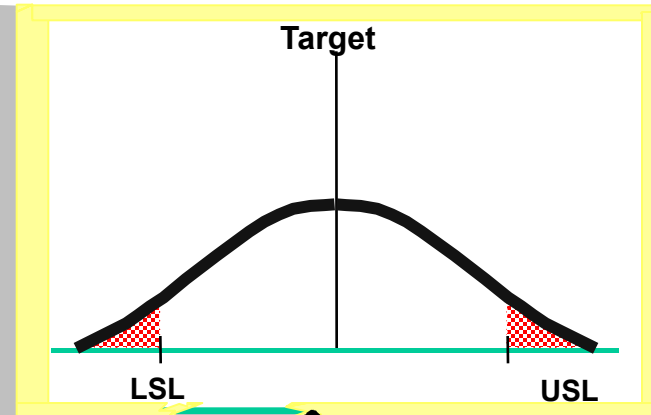


Variation - Reduce and Center

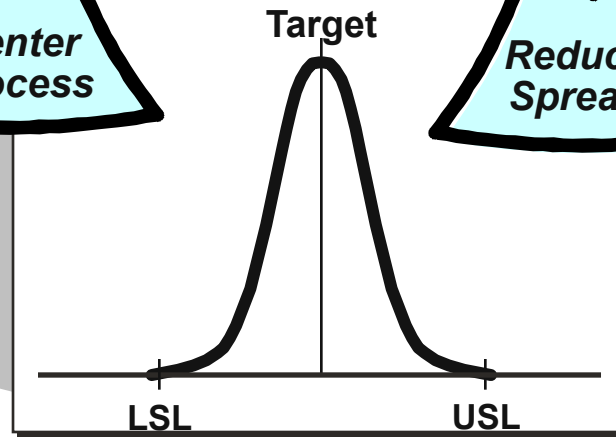
Process Off Target



Excessive Variation



Defects



Customers feel the variation more than the mean (the average)

WHAT IS THE TERM “SIGMA”?



A symbol that designates the **spread** of measurements around the average

- The **sigma capability**
 - Metric that indicates how well that process is performing.
 - The higher the sigma capability, the better.
 - Measures the capability of the process to perform **defect-free** work.

A defect is anything that results in customer dissatisfaction.

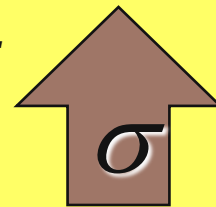
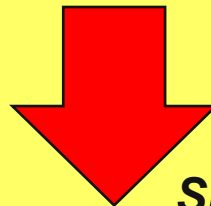
IMPACT OF SIGMA LEVEL

IMPACT OF SIGMA LEVEL

Process Capability	
σ	Defects / Million
2	308,537
3	66,807
4	6,210
5	233
6	3.4

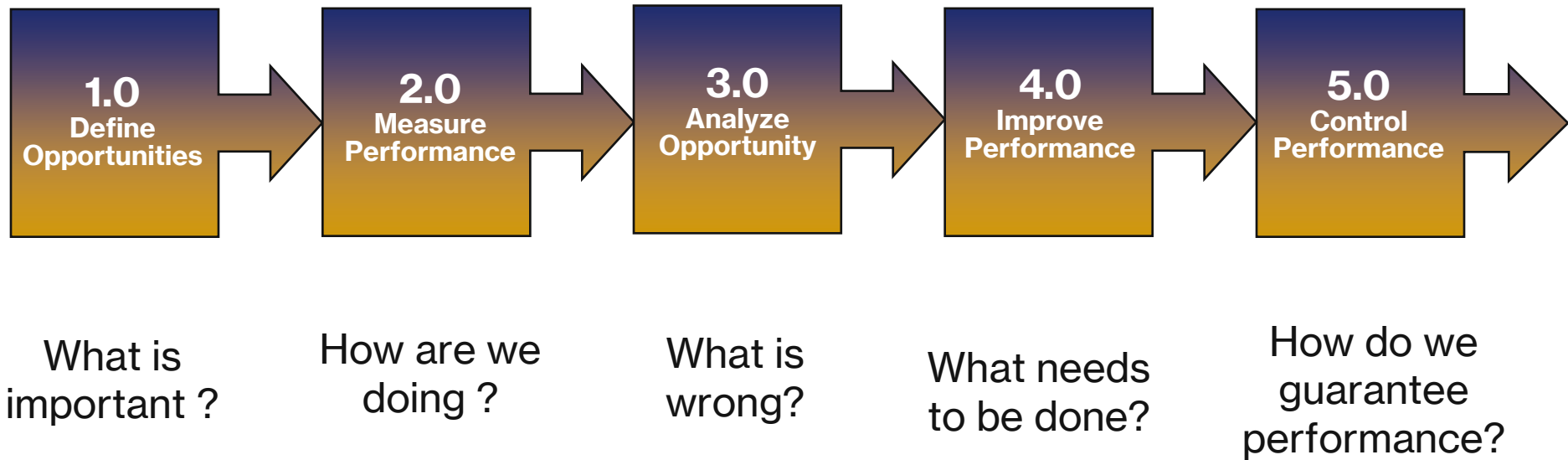
σ	% Non-Defective
2	69.1%
3	93.32%
4	99.379%
5	99.9767%
6	99.99966%

As defects
go down...



Sigma Capability
goes up

THE **DMAIC** MODEL FOR PROCESS IMPROVEMENT



THE DMAIC MODEL FOR PROCESS IMPROVEMENT



Objectives

- Identify and/or validate the business improvement opportunity
- Define critical customer requirements
- Document (Map) processes
- Build effective Teams

Objectives

- Determine what to measure
- Manage measurement data collection
- Develop and validate measurement systems
- Determine sigma performance

Objectives

- To Analyze data to understand reasons for variation and to identify potential root causes
- To stratify and analyze the opportunities for improvement
- To identify a specific problem and define an easily understood problem statement.

Objectives

- Develop and quantify potential solutions
- Improve/Optimize the process
- Evaluate and select final solution
- Verify, and gain approval for final solution
- Implement the final solution

Objectives

- To guarantee that process improvements are maintained.
- To ensure that new process problems are identified and quickly corrected.
- To disseminate lessons learned, and to identify replication and standardization opportunities

Statistics

A collection of methods for:

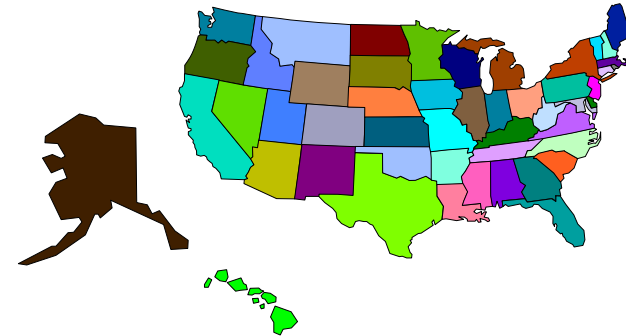
- Planning Experiments
- Obtaining...
- Organizing...
- Summarizing...
- Presenting...
- Analyzing...
- Interpreting...
- and Drawing Conclusions from...

DATA

Parameter:

A number that describes a population characteristic.

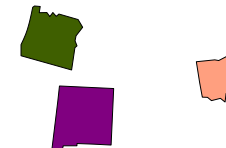
*Average age of all people
in the United States*



Statistic:

A number that describes a sample characteristic.

*Average age of people from a sample of
three states.*



Types of Data

- **Attribute Data** — Pass/fail data obtained by simply counting defects (25 good / 7 bad)
 - ◆ Attribute data becomes ineffective at low defect levels.
- **Variable/Continuous Data** — Measured data such as 44mm - data that can be subdivided into smaller increments
 - ◆ When evaluating low defect processes variable data must be used.

Attribute or Variable Data?

- 1. Attribute data provides no information about what caused the defect or what should be done to eliminate the defects in the future.
- 2. The relationship between what you see in a sample and what is going on in the population is weak and gets weaker as the process improves until finally there is no usable relationship.
- 3. Attribute data is primarily a “reactive” approach rather than a preventative method. When you have a pile of defects, it’s too late to fix it. With continuous data, you may be able to prevent the defects from happening in the first place.
- 4. As the process gets better, the sample size becomes extremely large and impractical when using attribute data.

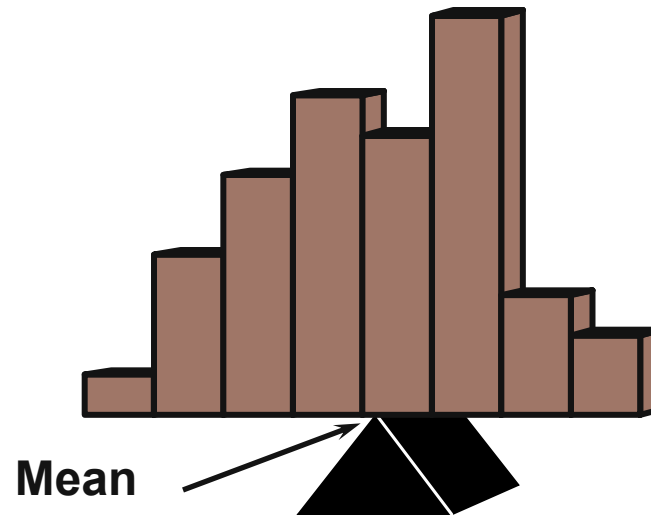
• **DO YOURSELF A FAVOR!! USE CONTINUOUS DATA NOW!**

Measures of Central Tendency

- **Mean**
- **Median**
- **Mode**

What is the Mean?

The mean is the arithmetic average of a set of numbers.



Think of the Mean as a balance point.

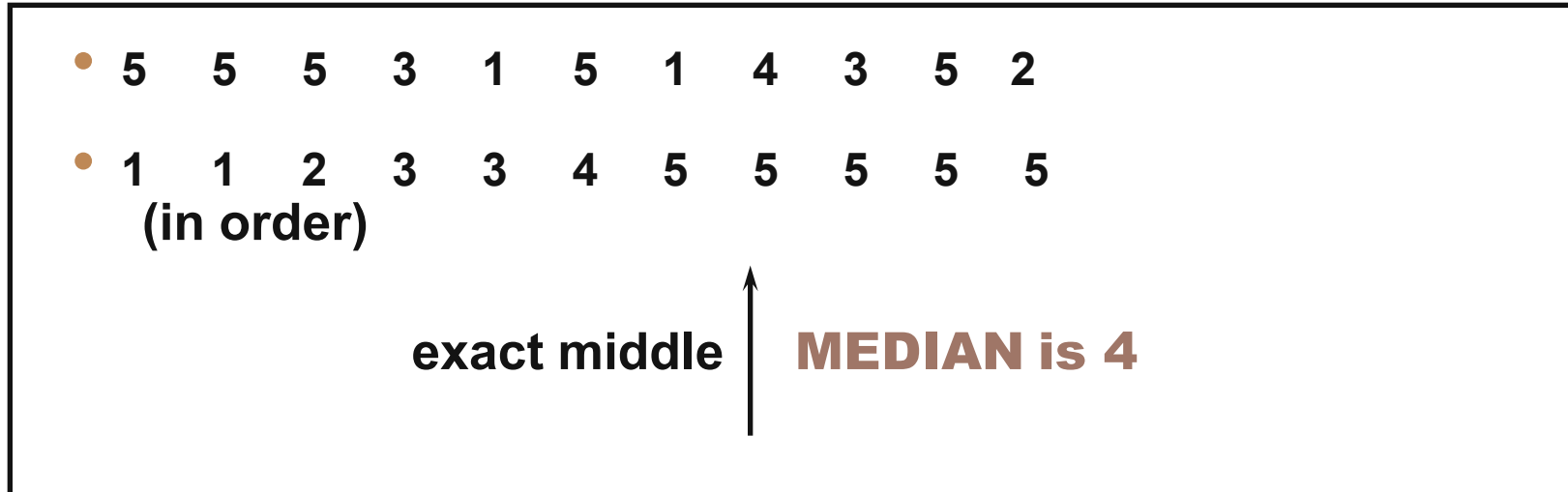
Measures of Central Tendency (continued)

Population mean – μ Sample mean - \bar{x}

- **Advantages of using the mean:**
 - It is the center of gravity of the data
 - It uses all the data
 - No sorting of the data is required
- **Disadvantages to using the mean:**
 - Extreme values may distort the picture
 - The mean may not be the actual value of any of the data points

What is the Median?

- Median is the middle value when data is arranged in ascending or descending order



Measures of Central Tendency (continued)

- **Advantages of using the median:**
 - Provides an idea where most of the data is located
 - Little calculation is required
 - Insensitive to extreme values (outliers)
- **Disadvantages to using the median:**
 - The data must be sorted and arranged
 - Does not use all the data
 - Extreme values may be important
 - Two medians cannot be averaged to obtain the median of a combined distribution
 - The median will have more variation (between samples) than the mean

What is Mode?

- ◆ The mode is the data value that occurs most frequently.
- ◆ It is the only measure of Central Tendency that can be used with ordinal data.

a.	5	5	5	3	1	5	1	4	3	5	2	➔	Mode is 5
b.	2	2	2	3	4	5	6	6	6	7	9	➔	Bimodal
c.	2	3	6	7	8	9	10	11	5	14	1	➔	No Mode

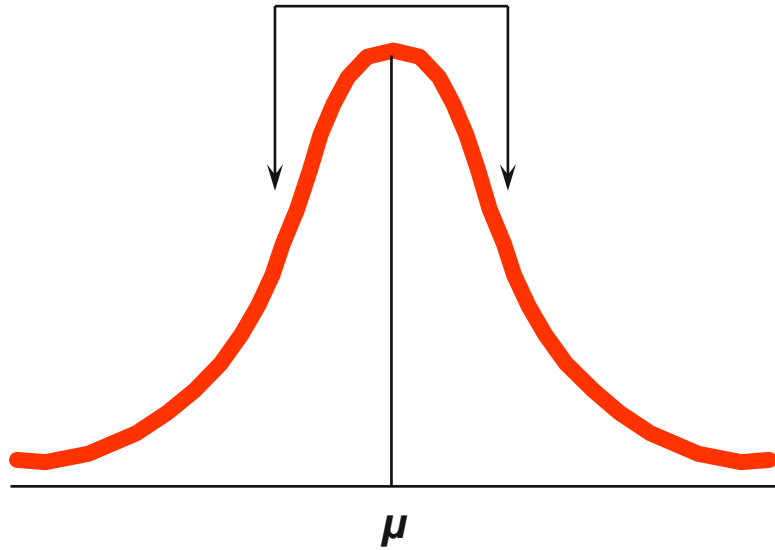
Measures of Central Tendency (continued)

- **Advantages of using the mode:**
 - It can be detected visually in distribution plots
 - No calculation or sorting is required
 - Insensitive to extreme values
 - It is an actual value
- **Disadvantages to using the mode:**
 - The data may not have a mode

What are 'Normal' Data?

- "Normal" data are data that are drawn (come from) a population that has a normal distribution. This distribution is inarguably the most important and the most frequently used distribution in both the theory and application of statistics. If X is a normal random variable, then the probability distribution of X is normal.

Normal Distribution



- Bell – shaped
- Mean = Median = Mode
- Unimodal (one mode)
- Symmetrical about the mean
- Curve is continuous (no gaps)
- Curve never touches the x-axis (asymptotic)
- Area under the curve is 1

Standard Deviation

- Formulae for standard deviation:

Population

$$\sigma = \sqrt{\frac{\sum (x - \mu)^2}{N}} \quad \text{where :}$$

σ = population standard deviation, sigma

μ = population mean, mu

Sample

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}} \quad \text{where :}$$

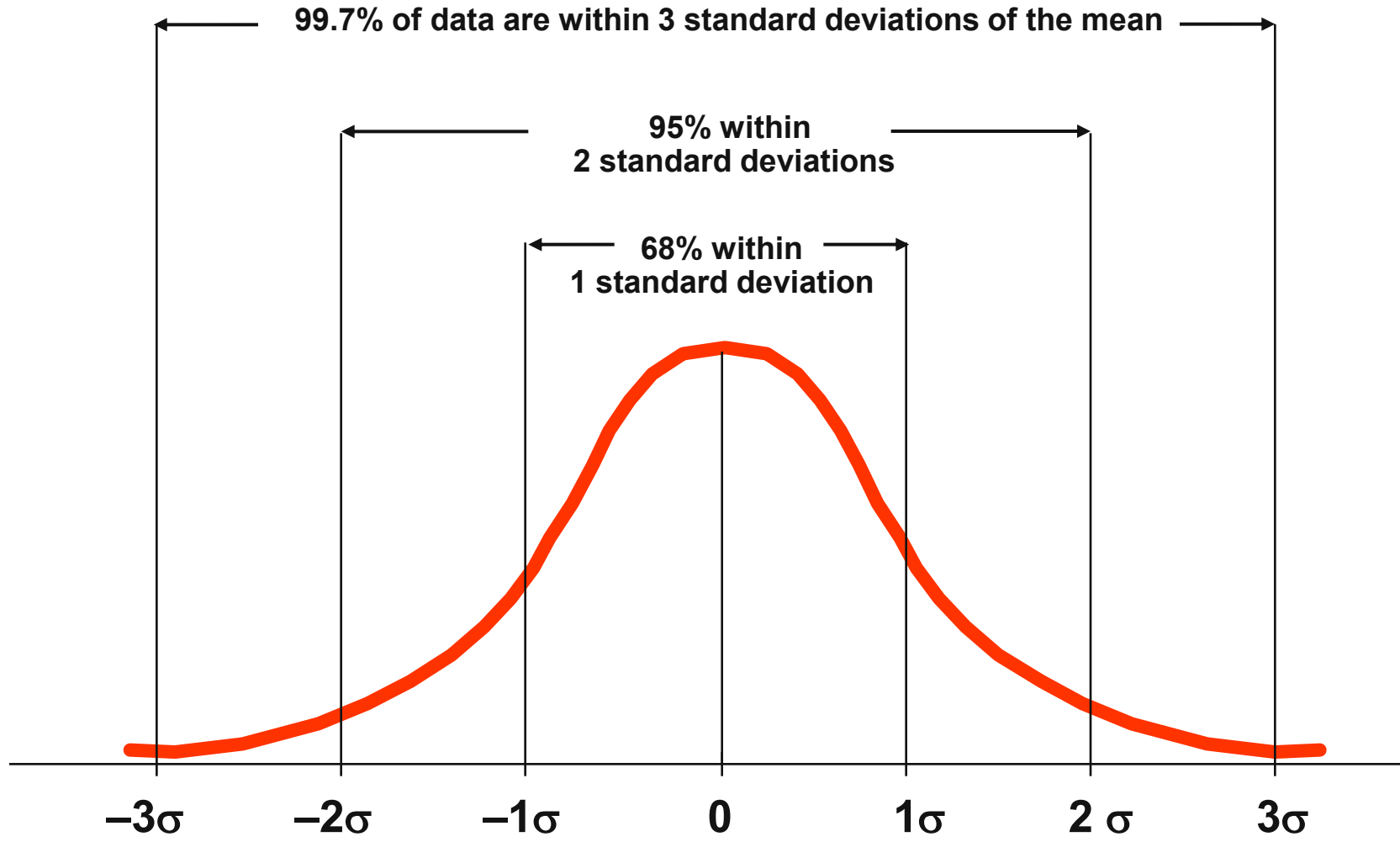
s = sample SD

\bar{x} = sample mean

n = number in the sample

- The population variance can be estimated by squaring the sample standard deviation.

The Empirical Rule



SOME HELPFUL TOOLS

Process Control

- Control Charts

Root Cause & Corrective Action

- Cause & Effect – Ishikawa or fishbone diagram
- 5WHYs
- 8-D
- Pareto Chart

Process Control

Control Charts

Causes of Variation

- Common Cause - sources of variation within a processes that has a *stable, repeatable, and predictable* distribution *over time*. Such a distribution is said to be *“in control”*.
- Although variation is undesirable, the predictability of common causes allows them to be identified and removed.
- Common causes are removed via *Process Characterization*

Causes of Variation

- Special Cause - Sources of variation that are not always acting on the process. They change the process distribution in unpredictable ways.
 - The unpredictable nature of special causes makes them difficult to identify and prevent.
 - **Special causes** are often *controlled*, rather than prevented, through the use of in-process *inspection* and *control charts*.

Examples of special causes: equipment failure, bad raw material, power outage.

Control Charts

- Control Charts, also called Shewhart charts, are trend charts that are used to provide *real-time* monitoring of processes.
- Decision rules are used to determine whether the process is currently in control.
- The specific type of control chart used depends upon the kind of measurement data being recorded.

Types of Control Charts

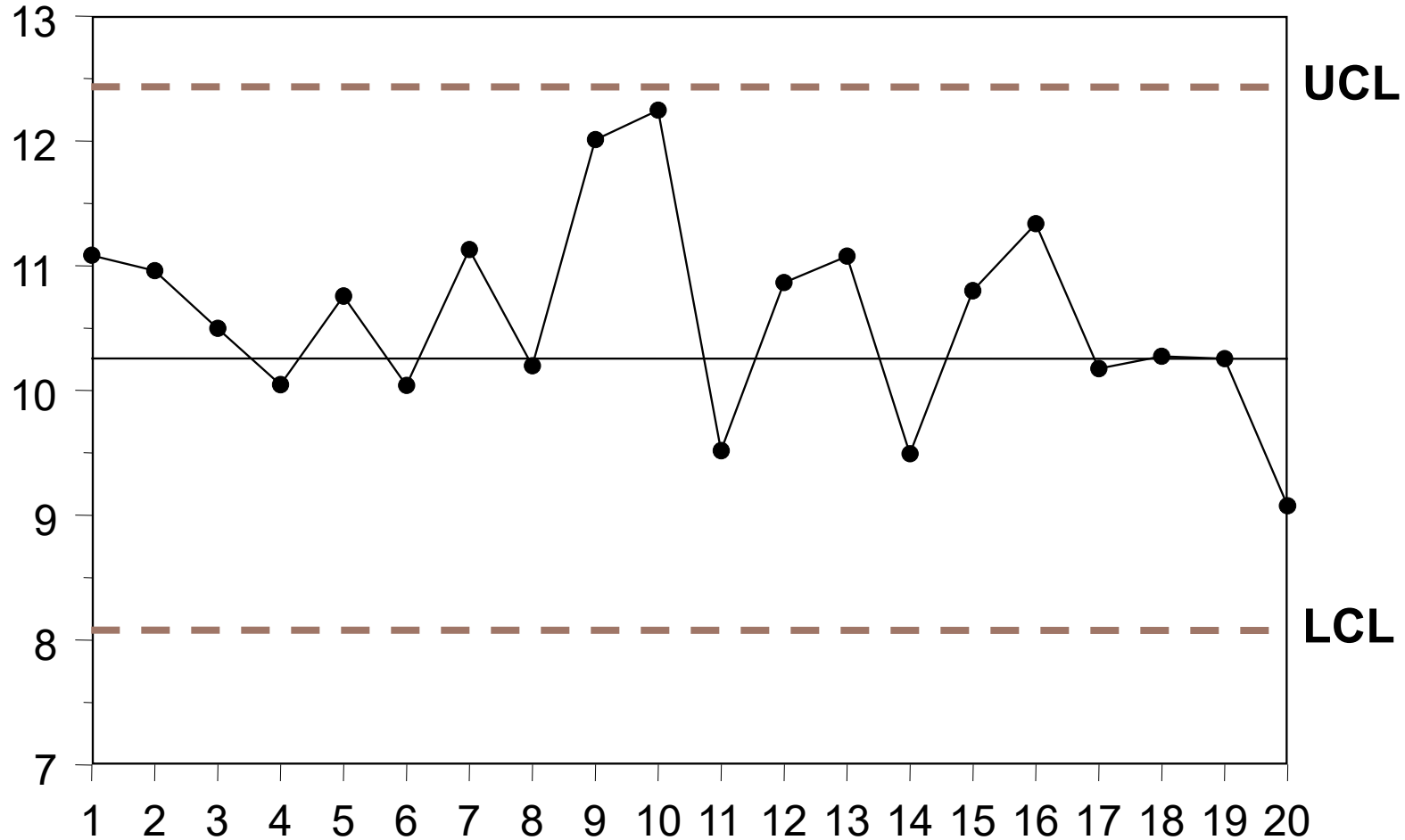
- **Variables Control Charts** for Measurement Data
 - Average and Range Charts
 - Average and Standard Deviation Charts
 - Median Charts
 - Charts for Individuals and Moving Range

- **Attribute Control Charts** for Pass/Fail Data
 - The p Chart for Proportion Nonconforming
 - The np Chart for Number Nonconforming
 - The c Chart for Number of Nonconformities in Inspection Equal Size Lots (for nonconformities scattered through a continuous flow of product: cloth flaws, bubbles in glass)
 - The u Chart for Number of Nonconformities Per Unit, where the sample size of subgroups may vary

Control Chart



Control Chart



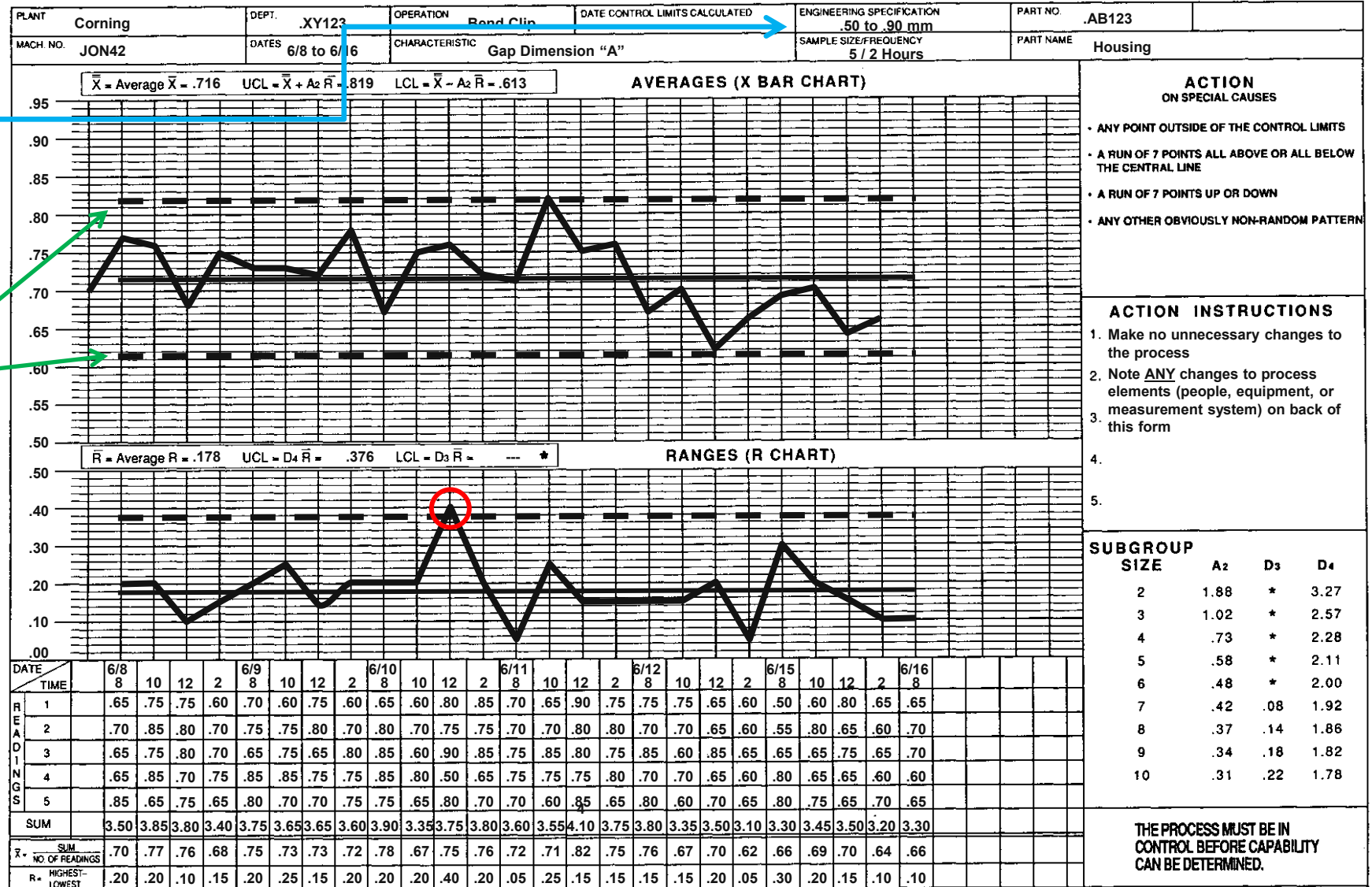


AVERAGE AND RANGE CHART

Spec limits determined by customer or technical requirement

Control limits are calculated from baseline data: Your process telling you how it's doing

CONTROL CHART



* For sample sizes of less than seven, there is no lower control limit for ranges.



**In God we trust.
All others must bring data.**

W. Edwards Deming

ROOT CAUSE AND CORRECTIVE ACTION

- **8-D**
- **Cause and Effect diagram
(Ishikawa/fishbone)**
- **5WHYS**
- **PARETO Chart**

8-D – EIGHT DISCIPLINES OF PROBLEM SOLVING

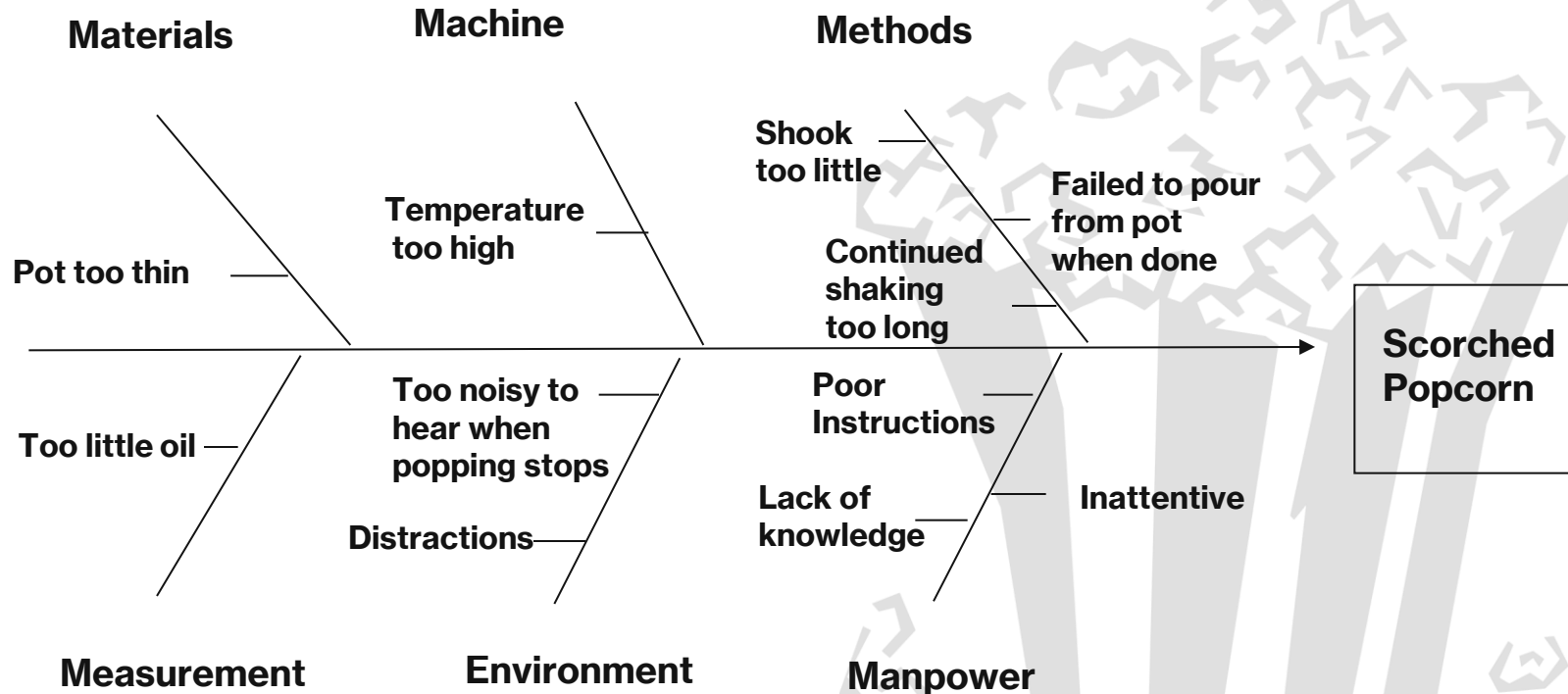
- Originally developed by Ford for the automotive industry
- **D0: Preparation and Emergency Response Actions:** Plan for solving the problem and determine the prerequisites. Provide emergency response actions.
- **D1: Use a Team:** Establish a team of people with process knowledge. Teammates provide new perspectives and different ideas when it comes to problem solving.
- **D2: Describe the Problem:** Specify the problem by identifying in quantifiable terms the who, what, where, when, why, how, and how many (5W2H) for the problem.
- **D3: Develop Interim Containment Plan:** Define and implement containment actions to isolate the problem from any customer.
- **D4: Determine and Verify Root Causes and Escape Points:** Identify all applicable causes that could explain why the problem has occurred. Also identify why the problem was not noticed at the time it occurred. All causes shall be verified or proved. One can use five whys or Ishikawa diagrams to map causes against the effect or problem identified.

8-D (CONT'D)

- **D5: Verify Permanent Corrections (PCs) for Problem that will resolve the problem for the customer:** Quantitatively confirm that the selected correction will resolve the problem. (Verify that the correction will actually solve the problem).
- **D6: Define and Implement Corrective Actions:** Define and implement the best corrective actions. Also, validate corrective actions with empirical evidence of improvement.
- **D7: Prevent Recurrence / System Problems:** Modify the management systems, operation systems, practices, and procedures to prevent recurrence of this and similar problems.
- **D8: Congratulate the Main Contributors to your Team:** Recognize the collective efforts of the team. The team needs to be formally thanked by the organization.

Similar structure to Corrective Action Report (CAR). May be tailored for your business and for the scope of the problem.

Ishikawa (Cause and Effect) Diagram



FISHBONE TEMPLATE



Fishbone
template

5WHYS

Problem statement: The vehicle will not start.

Why?

The battery is dead.

Why?

The alternator is not functioning.

Why?

The alternator belt has broken.

Why?

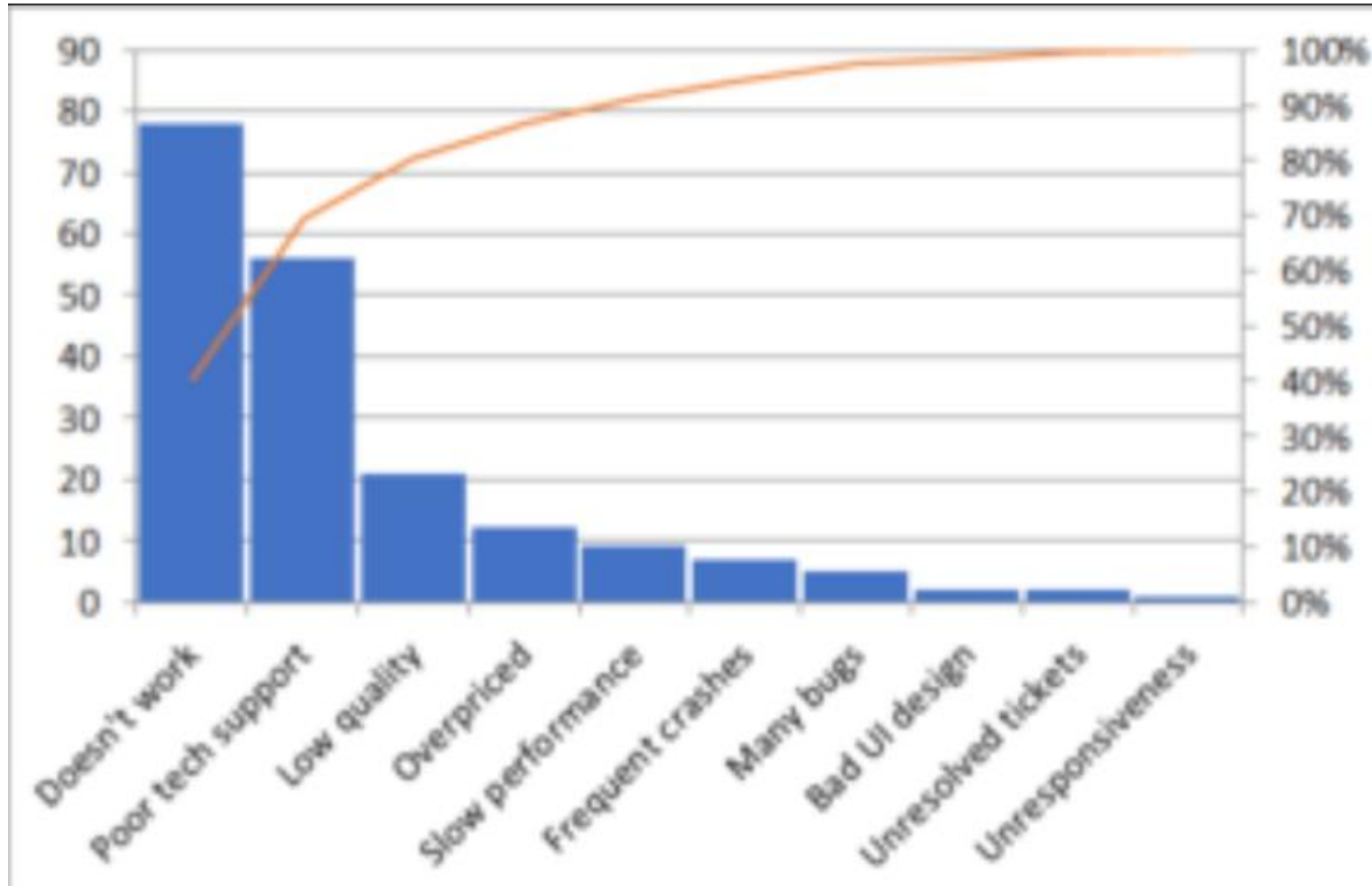
The alternator belt was well beyond its useful service life and was not replaced.

Why?

The vehicle was not maintained according to the recommended service schedule.



Pareto chart



Software complaints

- **First things first – 80-20 rule:**
In many processes, 80% of the causes are represented by the top 20% of categories.
 - Go after the top 20
 - Measure the process again
 - Go after the next 20%
 - Repeat

SIX SIGMA RESULTS

Six Sigma Process Characterization

- Motorola – cell phone component defect reduction and efficiency improvement
- Began in northern IL (Chicago area)
- Expanded internationally: US/Mexico/Germany/Singapore



Process Characterization Workshop

2000 Northern IL PCW Performance

Team	Results	Annualized Cost Savings
Vibrator	30% reduction of vibrator failures; Ni plating spec and ALT parameters changed.	\$1,220,000
LCD	Quality problems with Polaris LCD; reduced bonding defects from 4000 PPM to 400 PPM.	\$4,000,000
LCD	Reduce display missing pixel defects from 2400 PPM to 500 PPM.	\$75,000
Power Amplifier	Reduced defects from 16,000 PPM to 2500 PPM.	\$758,000
Crystal	Internal yield at 64%: eliminate failures for spurious frequency response from 60% to 85%.	\$750,000
LCD	ITO Corrosion due to contamination. Reduce ITO failures from 500 PPM to 35 PPM.	\$260,000
Crystal	Improve supplier rolled yield from 73% to 85%; on-time delivery to Motorola.	\$20,000

Total estimated 2000 savings \$7,083,000



2001/2002 Northern IL PCW Performance



		2001	2002
26MHz Crystal Oscillator	Eliminate microphonics issues on P2K products.	\$1,299,700	\$3,121,650
ITO Corrosion	Risk assess P2K programs and drive corrective actions as needed.	\$1,000,000	\$3,600,000
Metal Housing	Reduce cosmetic defects on flip outer housing to <5%.	\$1,628,700	TBD
LCD	Reduce EL Bonding failures to less than 100 PPM.	\$59,425	\$1,188,500
I/O Connector	Identify and eliminate root cause of J1 connector failures.	\$45,700	-
LCD	Improved LCD lighting resulting in increased throughput.	\$1,200,000	-
		\$5,233,525	\$7,910,150



2001/2002 Global PCW Performance

Team	Problem/ Goal	Estimated Cost Savings	
		2001	2002
PCB	Flensburg Eliminate PCB delamination.	\$983,750	\$1,117,500
LCD	Asia Eliminate display glass cracks.	\$89,230	\$621,600
Alert	Improve alert noise from 5000 PPM to 200 PPM.	\$43,660	\$304,100
Ring Plating	Increase metallization yield from 50% to 85%.	\$2,760	\$11,040
Laser Welding	Reduce cosmetic issues by 10%.	TBD	-
M-flex Keypad	Resolve poor keyboard tactile feel issue - .03 dphu.	\$5,200	\$20,800
Display Lens	Mexico Eliminate particulate on phone lens. (20% of the defects)	-	\$17,868
Integrated Circuit	Improve yield by .24 dphu.	-	\$239,200
Flip Assembly	Reduce low battery back-up power defects from .1 to .03 dphu.	-	\$1,665,840
LCD	Eliminate no or garbled graphics. (1.8 dphu improvement)	-	\$720,000

\$1,124,600 \$4,717,948

EXERCISE – DISCOVERING INEFFICIENCIES

- Handout
- This is the supplier quality history of an aviation distributor
- Identify 3 things that may require further analysis
- What actions should be taken?

EXERCISE - DEBRIEF

QAMFORM8 - RECEIVING MATERIAL DISCREPANCY LOG							
Date	PO/RO number	P/N	S/N	QTY	Supplier	Discrepancy	Action Taken
6/5/2026	PO-100	52737	5654	10	AeroComponents	Missing trace and wrong S/N	TBD
5/20/2025	RO-254	28366	2711	1	AeroGoods MRO	SB not documented on paperwork	Email request for correction
11/2/2025	RO-166	71016	2734	2	AeroGoods MRO	Missing Teardown report	Email request for correction
4/21/2025	RO-163	80104	3838	1	AirRepair	SB not documented on paperwork	Revision request made
9/11/2025	RO-145	13531	5737	7	AirRepair	Missing required AD on RO	Email request for correction
1/17/2025	PO-65	36326	2891	3	AV Components	Old CMM on paperwork	Piece-parts returned to shop, Units re-overhauled at MRO
6/5/2025	PO-160	68279	9901	8	AV Components	Wrong quantity received	Request RMA for correct shipment
12/15/2025	PO-180	11828	5332	1	AV Components	Missing trace	Email received with corrected paperwork
2/22/2026	PO-182	74558	3730	1	AV Components	Wrong quantity and cost on invoice	Email sent by accounting
4/14/2025	PO-150	30805	4147	1	SkyParts	Incorrect date in 14e. on FAA/EASA	Email request for correction
7/8/2025	PO-172	98796	9215	5	SkyParts	8130 missing signature	Email request for correction
1/14/2026	PO-181	62900	9638	1	SkyParts	Wrong P/N	Request RMA for correct part
2/27/2026	RO-170	80347	7243	10	SkyParts	Missing removal tag	Missing removal tag
3/31/2026	PO-188	88829	7993	5	SkyParts	Missing last operator on 8130	Missing last operator on 8130
4/30/2026	PO-190	90973	1161	1	SkyParts	Wrong S/N - doesn't match PO	Wrong S/N - doesn't match PO
5/29/2026	PO-3	46122	3310	8	SkyParts	RMA request - 2nd notice - missing trace	RMA request - 2nd notice - missing trace

Just a few of many possible issues...

- Who has caused you the most rework in the past 2 years?
- How long did each correction take?
- Do you measure how long parts are “ON HOLD” pending corrected paperwork or parts?
- When was PO-3 created, and how many calls/emails have gone back and forth since then?
- Do you have a single point of contact for handling supplier (or customer) issues? (Delivery, quality, financial)
- Have you ever issued Supplier CARs to your suppliers?

Don't' allow others' defects to contribute to your inefficiencies

SOME AUDITOR OBSERVATIONS

- Scanning trace documents, ATA106s, 8130s, etc. is OK
- Hand-written log sheets are OK, but scanned hard copies aren't searchable (without OCR)
 - **Electronically entered data is better – facilitates trend analysis**
- Sample records (3 of each) for relevant sections of your Internal Audit
 - Use objective parties whenever possible
 - Consider cross-training additional internal auditors
- Utilize tools available within your ERP system to track due dates
 - Expiration of certificates on your Approved Supplier List – prevent PO creation if unapproved
 - Expiration dates of shelf-life materials
 - Cycles/dates on Life-limited parts
- Exercise and encourage the use of Corrective Actions for internal –and external- issues found

WHAT ABOUT LEAN SIX SIGMA?



- Many companies are combining these two initiatives into one
- Risk of watering down each and not getting the full benefit
- Two robust toolkits which deserve rigorous study and application

QUESTIONS?





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Offerings

Aerospace Certification – prep for accreditation

- ISO 9001
- AS9100
- AS9110
- AS9120
- ASA-100

QMS training

- Internal Auditor
- Root Cause & Corrective Action

Six Sigma

- Six Sigma Program - Management Overview
- Green Belt
- Black Belt

Tony Cafarchio <tonycafarchiosr@gmail.com>

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