Supplier Quality Management

Continuous Improvement Training

DMAIC

AQDT - Strategic Engagement Team | Q1 2026

Agenda

- Review Goals
- Review Supplier Performance
- Understand the *DMAIC* process and components
- Short Video on DMAIC Introduction
- Q&A
- Closing

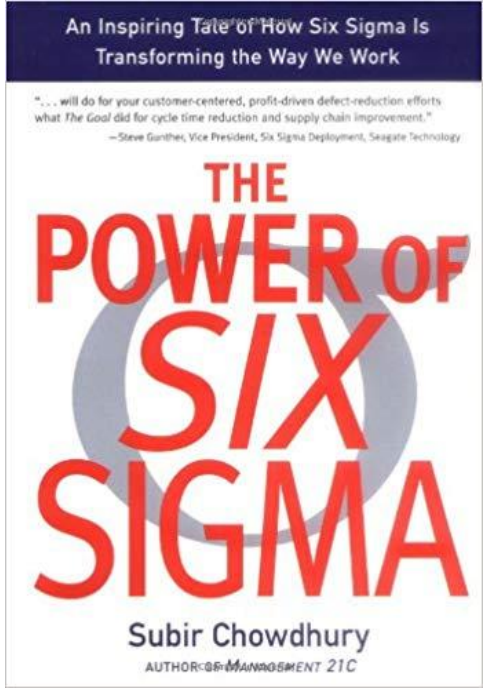
FOR REFERENCE ONLY

Supplier Performance Review

NOTE: This slide to include “Supplier Performance Specific Data Only”, not LMPI data/information.

DMAIC

- Five Phase methodology: Define – Measure – Analyze – Improve – Control
- It is an industry standard Lean Six Sigma (LSS) data driven methodology used to solve complex business problems.
- A roadmap for continuous improvement
- This methodology may appear sequential but should be considered an iterative process
- Many of the same tools can be used in different phases

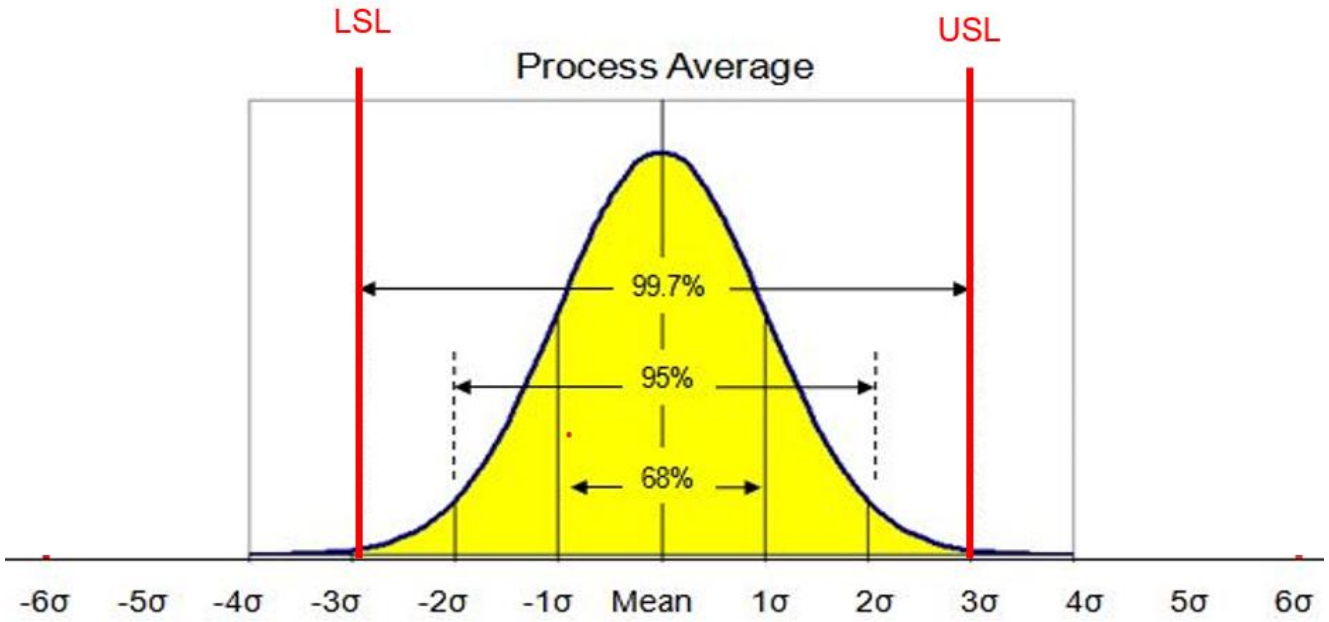


A Problem-Solving Methodology

DMAIC – Lean Six Sigma

Sigma is a **statistical** measurement of variability, showing how much variation exists from a **statistical** average. **Sigma** measures how far an observed data deviates from the mean

$$\sigma = \sqrt{\frac{\Sigma (x - \mu)^2}{N}}$$



DMAIC Phase High Level Overview

Define
Clearly identify the problem; define the project goals

Measure
Complete Measurement System Analysis and determine baseline performance

Analyze
Assess the problem and determine Key Process Input Variables (KPIVs)

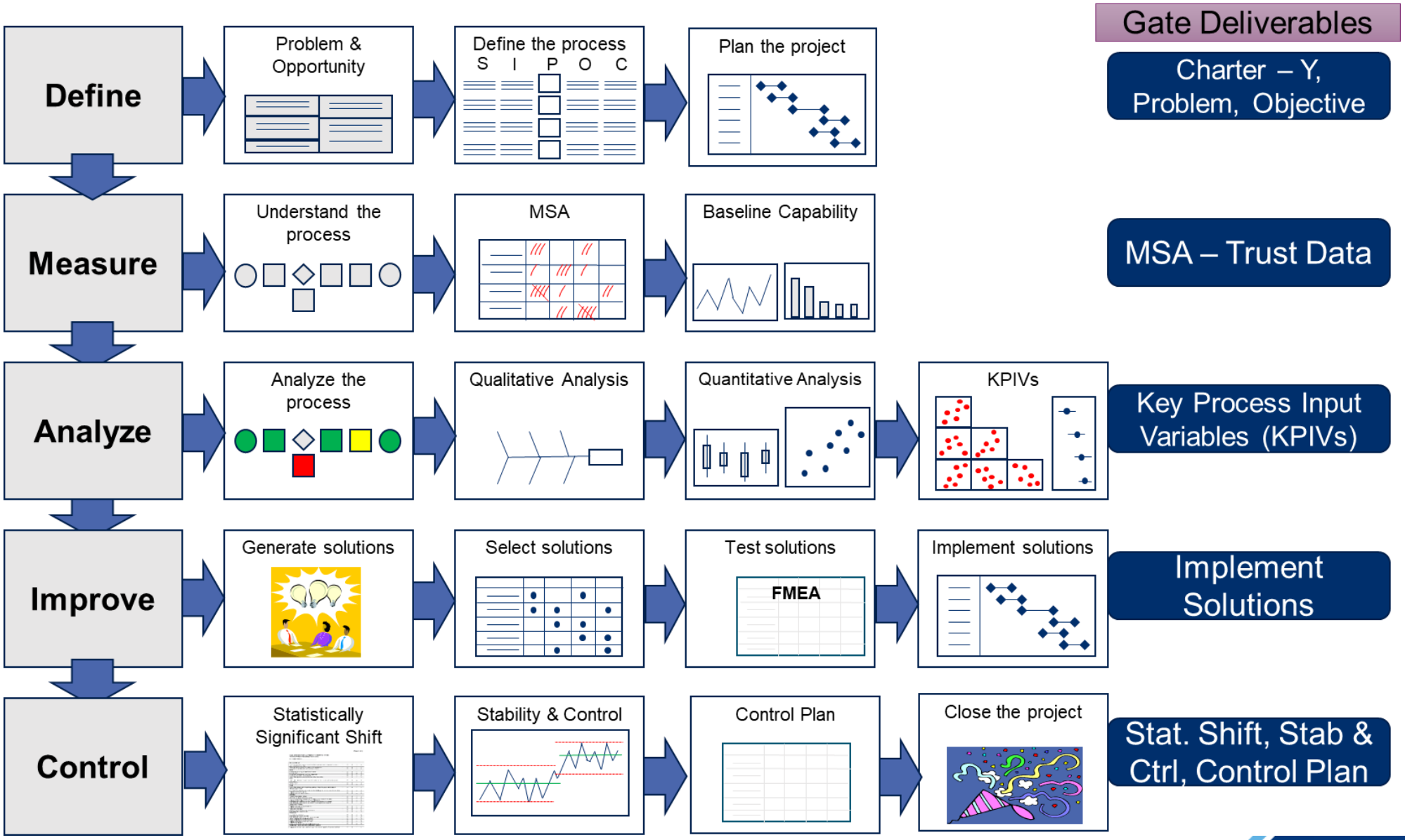
Improve
Identify solution(s) based on KPIVs and implement changes to improve the process

Control
Ensure proven gains sustained with a plan in place for process control

DMAIC Roadmap

Define	Create Project Definition	Align Project/ Set Goals	Define Scope	
Measure	Validate 'Y' Measurement System	Establish Baseline Stability & Capability	Review Performance Objectives	
Analyze	Identify Inputs (x's) and Waste	Analyze Process Flow	Quantitative/ Qualitative Analysis	
Improve	Identify Solution	Plan Improvements	Implement Improvements	
Control	Develop Control Strategy	Determine Final Process Stability & Capability	Implement Process Controls	Wrap up Project

DMAIC Journey

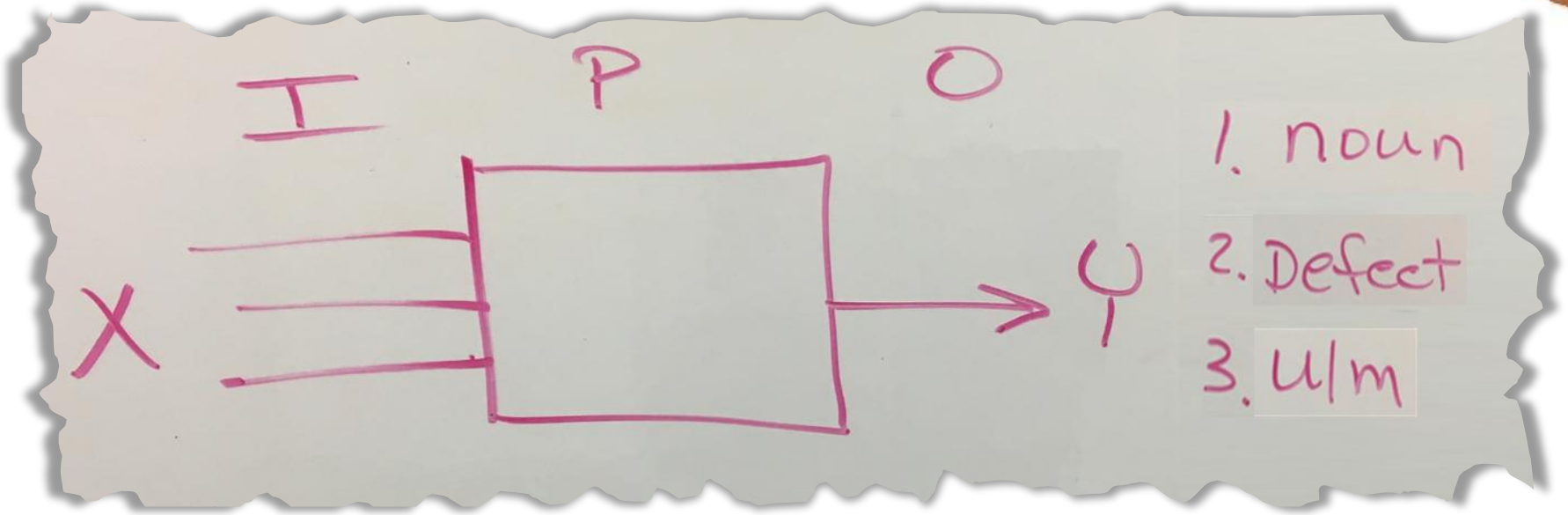


Define Phase

The Map	Create Project Definition	Align Project/ Set Goals	Define Scope
Useful Tools and Concepts	• Problem Statement, Objective, 'Y' • Benefits • Scope • RACI / RAPID™ • Stakeholder Analysis	• Survey, Focus groups, etc.	• SIPOC • Data Collection Plan • Communications Plan
Key Actions	• Form Team • Create project plan • Benchmark • Identify Stakeholders • Strategize Change Management	• Align to business goals • Assessed impact on Triple Constraint/CTQ *(Cost, Time, Quality)* • Create Definitions & Acronyms list	• Drafted Data Collection Plan
Required Deliverables	• Charter • Loaded in Project Tracker	• Showed Business Alignment • Project Specific Acronyms & Definitions	• SIPOC

Key take away: Problem, Objective, Y

Problem Statement
IPO – NUD - POY



Problem	Donut scrap rate too high (50%)
Objective	Decrease donut scrap rate from 50% to 5% by 12/31/19
Y	Donut with diameter > 15 cm

Define Phase

Purpose	Deliverables	Tools

• What is the problem?
• What is the objective?
• Who are the stakeholders?
  • Champion
  • Process Owner
  • Team Members
  • Customers, SME
  • Those using or affected by the process
	Project Contract	• Project Contract
		• GRPI
		• Stakeholder Analysis

Why is this project important?	Graphical Link To Critical Business Lever	• GDP X-Matrix • Cascaded Objectives • PMP Objectives • VSM, CTQ

What is the financial benefit of this project?	• Quantified Savings (hard and/or soft)
	• Other Benefits to:
	  • Company
	  • Employees
	  • Suppliers
	  • Customers
		• Spreadsheets

Measure Phase

The Map	Validate 'Y' Measurement System	Establish Baseline Stability & Capability	Review Performance Objectives

Useful Tools and Concepts	• Measurement Systems Analysis (MSA)
	  - Audit
	  - Attribute R&R
	  - Variable R&R
	• Time Observations
	• Standard Work
		• As-Is Process Map
		• Control Chart
		• Run Chart
		• Capability Analysis
		• Normality test
			• Cost Benefit Analysis

Key Actions	• Validate 'Y' Measurement System	• Execute data collection plan • Assess Stability and Control • Assess Process Capability	• Estimate savings and business value • Financials Loaded in Project Value Tracker
Required Deliverables	• MSA	• Baseline Data Table • Control Chart • Capability Chart • As-Is Process Map	• Statement that value has been loaded in the Value Tracker • Show calculations of savings

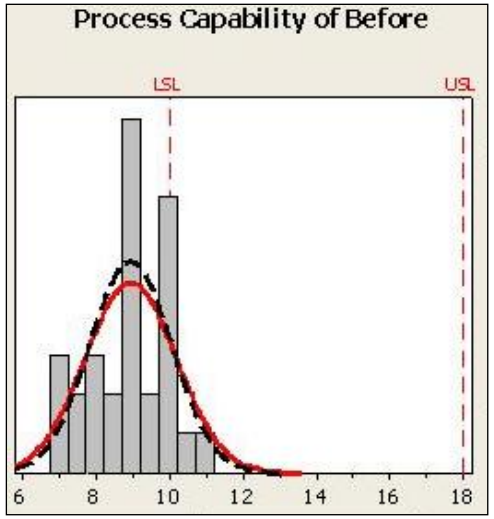
Key take away: Gain Trust in your data

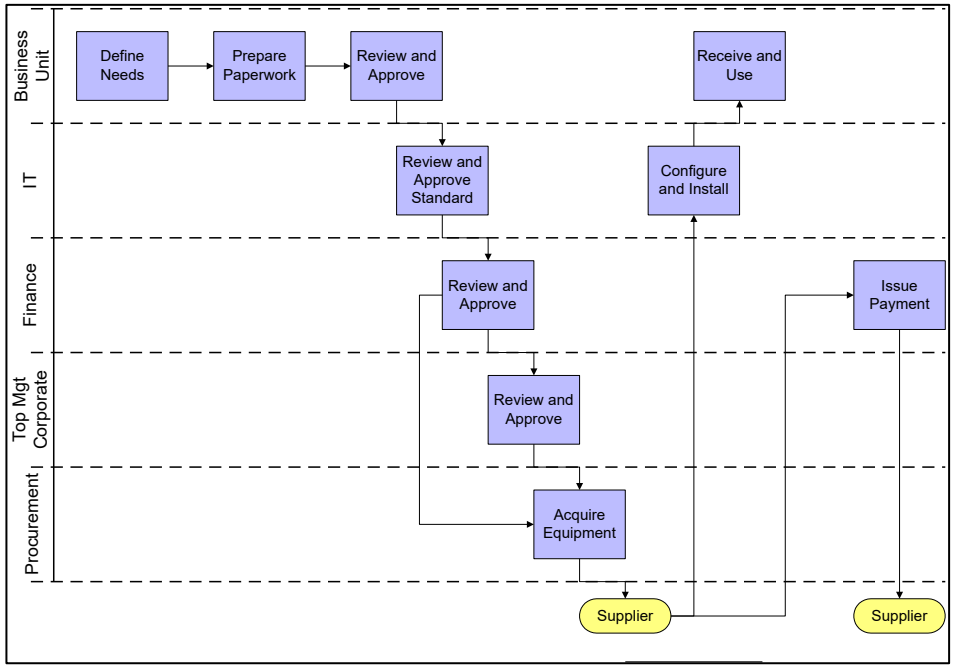
Measurement Phase

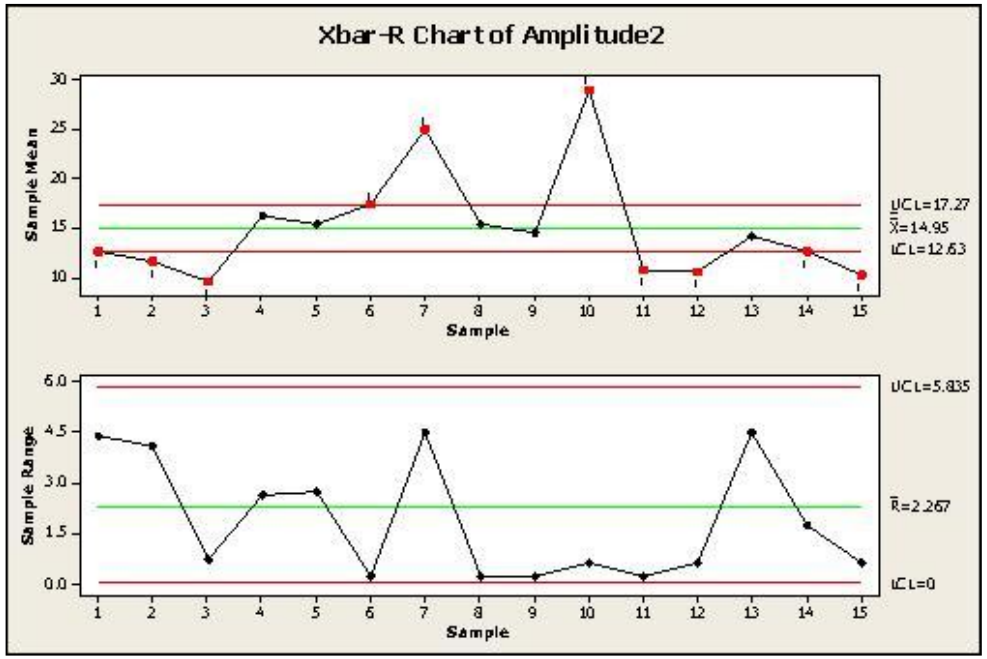
1. Measurement System Analysis*
2. Process Stability*
3. Baseline Capability*
4. Process Map*

Measurement System Analysis (MSA)

- 10 parts, 3 appraisers, 3 random times
- Want nearly all the variation in the parts not the appraisers or gages







Measure Phase

Purpose	Deliverables	Tools
• What is the process	• Graphical Depiction of the Current Process • Safety/Compliance Requirements Defined & Catalogued • Existing Policies & Procedures Catalogued	• SIPOC or IPO • Spaghetti Diagram • Flow Diagrams • Swim Lane Diagram • VSM – Current State • VA & NVA Analysis • Baseline Video and Pictures
Narrow the focus of the project	• Better Definition of the "Y" • Reduced List of Inputs or Steps	• Brainstorming • Basic Data Analysis (Pareto, run charts, etc.) • Fishbone Diagram • C&E Matrix, FMEA • 5S/EHS Audit • Takt Calculations

• Where do we obtain the "Y" data?
• Can we trust the measurement system that monitors the project "Y" and support metrics?
	• Data Source - Trust Level
	  • Red: Plan to fix?
	  • Yellow: Plan to fix or mitigate?
	  • Green: Good to go.
		• PAL (Pray A Lot)
		• Auditing
		• Attribute R&R Study
		• Variable R&R Study

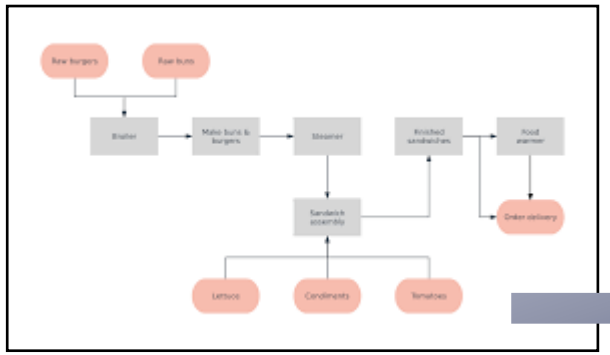
• What is the current capability of the process (the "Y") and its' support metrics? • At FPC, how will we measure the process improvements?	• Current Process Capability	• SPC or Capability charts • Setup I-MR Chart • Process Capacity • Noise to Constant Chart • Audit of Planning

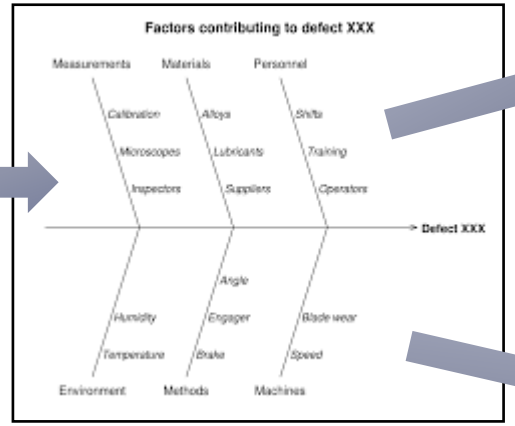
Analyze Phase

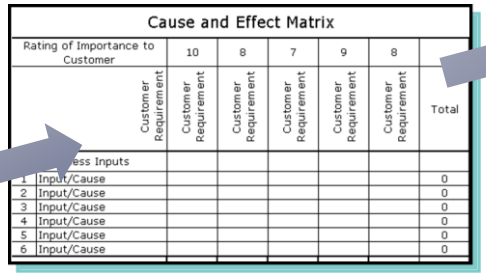
The Map	Identify Inputs (x's)	Analyze Process Flow	Quantitative/Qualitative Analysis
Useful Tools and Concepts	• Brainstorming • Fishbone	• Flow Principles • Cellular Layout • Inventory Management • Theory of Constraints • Systems Assessment • Gap analysis • Waste Walk • 8 Wastes	• ANOVA • Chi Square • Correlation • Regression • Hypothesis Test(s) • Pareto • Main Effects Plots • Cause Map • FOV • C&E Matrix • FMEA • Causal Analysis • DOE • Interaction Plots • 5-Why • Fault Tree
Key Actions	• Brainstorm x's (inputs)	• Analyze overall process • List of waste elimination opportunities	• Filter x's (inputs) to KPIVs • Consider safety and ergonomics • Perform causal analysis • Perform hypothesis tests
Required Deliverables	• Fishbone	• N/A	• C&E Matrix • FOV or Causal Analysis • List of Final Roster of KPIV's

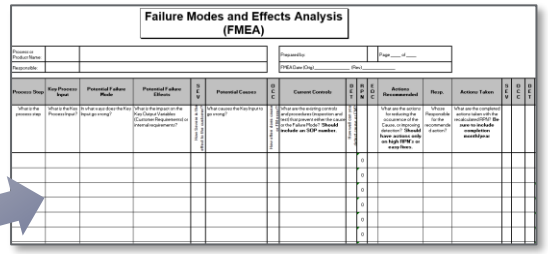
Key take away: Qualitative & Quantitative Analysis to find KPIVs

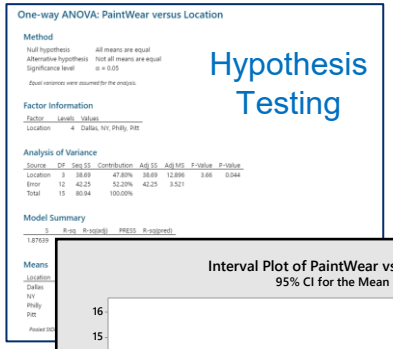
Analyze Phase



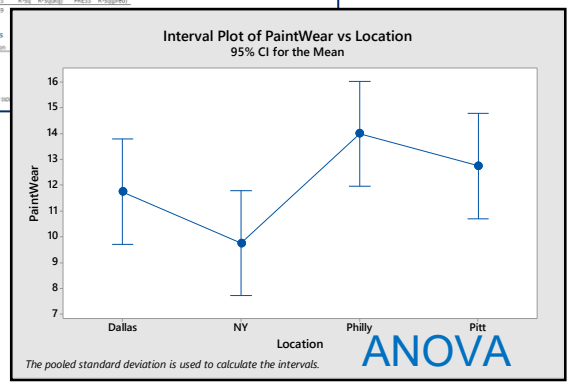






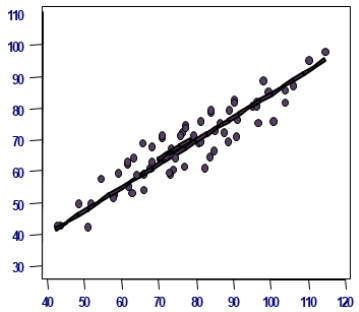


Hypothesis Testing

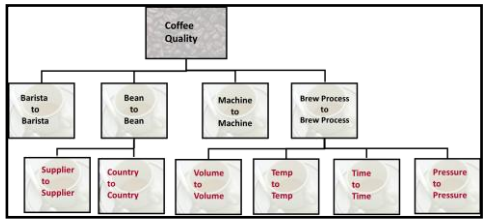


ANOVA

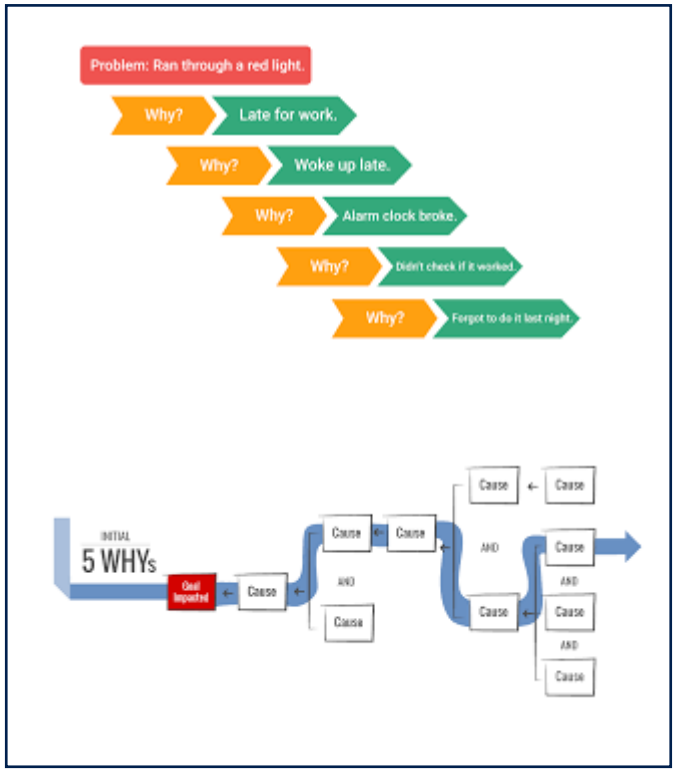
KPIVs



Correlation/ Regression



Families of Variation (FOV)



LOCKHEED MARTIN

Analyze Phase

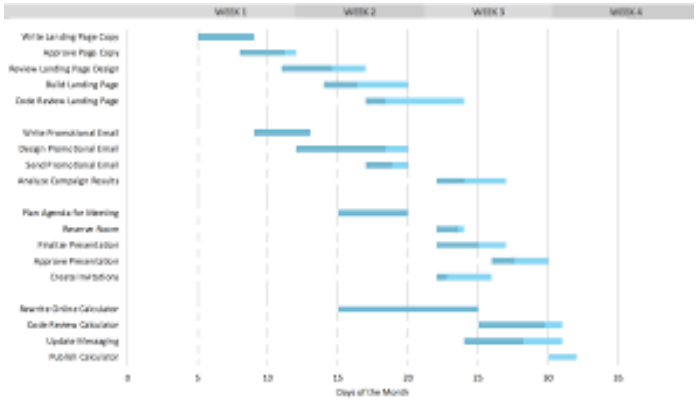
Purpose	Deliverables	Tools
• What factors contribute to variation in the “Y”?	• Graphical FOV Tree • Opportunities for Improvements	• Brainstorming • Fishbone Diagram • Process Maps • Basic Data Analysis • VSM – Current State with Starbursts • FOV Tree
• Quantitative Analysis - Without making changes in the current state what can we learn using data? • Analyze sources of variation from FOV tree.	• Opportunities for Improvements	• Basic Data Analysis • Box & Dot Plots • SPC Charts • ANOVA • Regression • Pareto of Setup Times • Operator Load Chart • Work Comb. Sheet • Standard Work Sheet • Time Observation • Process Capacity
• Qualitative Analysis - Without making changes in the current state what can we learn using data? • Analyze sources of variation from FOV tree.	• Opportunities for Improvements	• Brainstorming • FMEA • Profile on Change • Waste Walk • Internal / External Analysis • VSM, Hypothesis Testing

Improve Phase

The Map	Identify Solution	Plan Improvements	Implement Improvements
Useful Tools	• Poka Yoke • Set up Reduction/SMED • Total Predictive Maintenance (TPM) • 6S • Kanban • Regression	• Improvement Plan • FMEA (Mitigations) • Change Management Tools • Communication Plan • Piloting and Simulation	• Change Management Tools
Key Actions	• Brainstorm solutions to KPIVs • Rank solutions • Determine optimal levels of KPIVs • Ensure each solution is tied to a KPIV • Consider safety and ergonomics	• Determine improvement actions • Complete risk analysis • Strategize Change Management • Assess impact on Triple Constraint CTQ (Cost, Time, Quality)	• Communicate / collaborate with Stakeholders • Accelerate Improvement
Required Deliverables	• List of raw brainstormed solutions • Down-selected solutions • List of final solutions mapped to each KPIV	• Improvement Implementation Plan	• Improvements shown complete on the Improvement Implementation Plan

Key take away: Implement Solutions

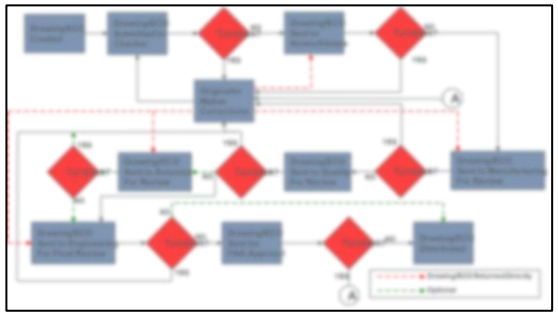
Improve Phase



Implementation Plan

Process Step	Key Process Input	Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	OCC	Current Controls	DET	RPN	Actions Recommended	Resp.	Actions Taken	SEV	OCC	DET	RPN
Receive Payment	Checks	Delay internal mail	AR balance does not go down	7	Inadequate staffing in mail room	7	None	10	490	Investigate mail room staffing and associated processes	G. Lee	Added another mail clerk. Adjusted dock schedule.	7	1	10	70
Identify Customer	Wire Transfer reference line	Information not supplied	AR balance is past due	10	Customer or bank did not include name and/or account info on wire transfer	5	Acct identifies problem when trying to apply payment	5	250	Poka-Yoke wire transer process	N. Peart	Contacted banks and established wire transfer procedure (DI 2112)	10	1	3	30
Identify Invoice	Checks	Incorrect invoice supplied	Invoice shows outstanding (AR balance does go down)	5	Customer error	5	Customer might catch it when reviewing the next statement	10	250	Provide payment stub with statement for each invoice	A. Lifeson	Revised statement to include payment stub with each invoice.	5	1	5	25
Identify Invoice	Checks	Invoice number not supplied	Invoice shows outstanding (AR balance does go down)	5	Customer error	10	Acct identifies problem when trying to apply payment	5	250	Provide payment stub with statement for each invoice	S. Hagar	Revised statement to include payment stub with each invoice.	5	1	5	25

FMEA 2nd Half



Process Map, Before & After (future state)

Piloting, Experimenting

Improve Phase

Purpose	Deliverables	Tools
• What improvements does the Team want to implement? • What experimentation is required (if any)?	• Improvement Plan • Experiment Plan (if experimentation is required) • Champion & Process Owner Approval	• Improvement Plan Worksheet • Kaizen Prep Worksheet • Stakeholder Analysis • Communication Plan
• What improvements were implemented? • How did experimentation progress (if any)?	• Improvement Story • Kaizen Story • Experiment Story	• Kaizen Event/Newspaper • Scheduling Board • Kanban Signals • Supermarket Stores • Poka Yoke • Standard Work • Experimentation (Trial & Error, Shotgun, OFAT, DOE)
• What was accomplished via improvements and/or experimentation? • Did we achieve our improvement goals?	• Improvement Summary	• 5S Radar Charts • Target Progress Report • Setup I-MR Chart • Action Plans • Updated Improvement Plan Worksheet • Final Process Maps • VSM – Future State • Work Instructions/SOPs
• Does the new process meet Safety/Compliance requirements identified in the Measure phase?	• Safety & Compliance Summary	• Final Process Maps • VSM – Future State • Work Instructions/SOPs • Policies & Procedures

Control Phase

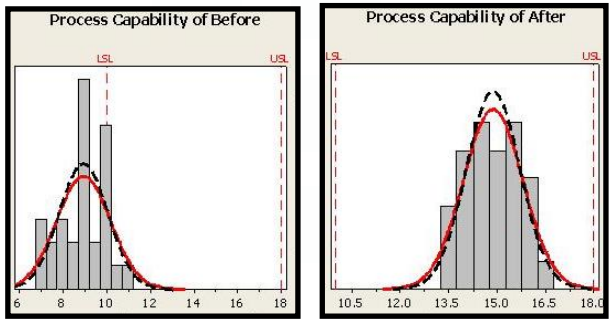
The Map	Develop Control Strategy →	Determine Final Process Stability & Capability →	Implement Process Controls →	Wrap up project
Useful Tools	• RACI / RAPID™ • Maintenance Checklist • Training • Process Map	• Stability Test • Control Chart • Run Chart • Capability Analysis • Hypothesis Testing • Normality Testing	• Documentation Control • Aero Code / Standard Work • Standard Operating Procedures (SOPs) • Control Plan	• Final Financial Evaluation
Key Actions	• Strategize sustainment of improvements	• Collect data • Conduct statistical analysis (before/after) • **Statistically Significant Shift in Y**	• Documentation institutionalized • Create method to monitor process • Train stakeholders	• Celebrate • Complete project review with stakeholders
Required Deliverables	• Updated Process Map	• Control Chart • Process Capability Chart • Sample Size Calculation for hypothesis test • Hypothesis Test	• Control Plan	• Show updated calculations of savings • Evidence that value has been updated in the Value Tracker

Key take away: Statistical Shift, Stability/Control & Control Plan

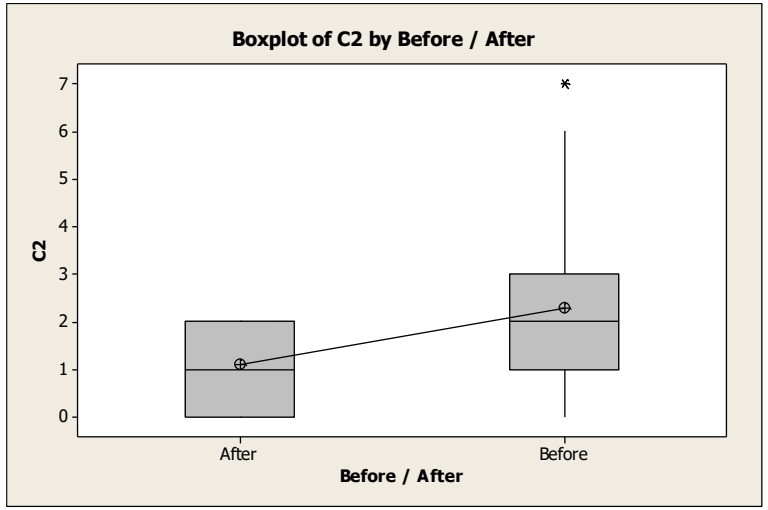
Control Phase

Sub Process	Sub Process Step	CTQ		Specification Characteristic	Specification/ Requirement	Measurement Method	Sample Size	Frequency	Who Measures	Where Recorded	Decision Rule/ Corrective Action	SOP Reference
		KPOV	KPIV		USL LSL							
Shipping	Picked not shipped report	x		Report - Consolidated Orders	30 days	Days Outstanding	All	Weekly	COOP System - Craycraft	CSS--Harveson	Who's responsible: Warehouse Manager- resolves any open SA more than 30 days	DI D31.1.2 Accuracy & 1K-001-01
Shipping	Picked not shipped report	x		Report - Standard Orders	10 days	Days Outstanding	All	Weekly	COOP System - Craycraft	CSS--Harveson	Who's responsible: Warehouse Manager- resolves any open SA more than 30 days	DI D31.1.2 Accuracy & 1K-001-01
Export/Spares Admin	Consolidated SA's		x	Days	25 days	Days Outstanding	All	Weekly	COOP System - Craycraft		Who's responsible: Terry Jeffcoat/Denea Tallman- require administrative action	DI 1K-015-01

Control Plan



Capability Before/After



Box Plot

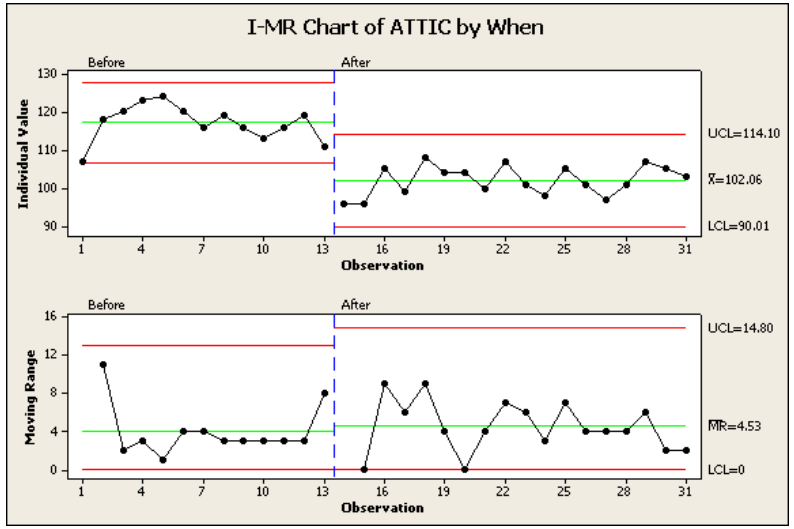
Two-Sample T-Test and CI: C2, Before / After

```
Two-sample T for C2

Before
/
After    N   Mean  StDev  SE Mean
After   19  1.105  0.809     0.19
Before  46   2.28   1.75     0.26


Difference = mu (After) - mu (Before)
Estimate for difference:  -1.17735
95% CI for difference:  (-1.81204, -0.54265)
T-Test of difference = 0 (vs not =): T-Value = -3.71  P-Value = 0.000  DF = 62
```

Hypothesis Test – Statistically Significant Test



Control Chart – Stability and Control

Control Phase

Purpose	Deliverables	Tools
• What controls are in place to maintain the improvements?	• Control Plan Document • Project contract/charter	• Poka Yoke • Maintenance Check List • 5S Check List • Scheduling Board • Kanban Signals • Supermarket Stores • Training • Standard Operating Procedures • Standard Work Playbook • Automation
Place control and ownership of the improvements with the Process Owner.	• Control Plan Sign-Off • Audit Plans	• Control Plan • RACI Matrix
What is the final capability of the process (the "Y") and its' support metrics?	• Final Process Capability • Final Project Benefits	• SPC, Capability or Control Charts • Noise to Constant Chart • Process Time to Lead Time • Final Target Progress Report

Close out the project.	• Final Presentation
	  • Financial Benefits
	  • Lessons Learned (next to last slide)
	  • Project Summary (last slide)
	• Signed Project Close-Out & Review
	• Project Closed in archival system
	• Project Communication to Stakeholders
		• Project Contract/Charter

Resources

- The Black Belt Memory Jogger
- The Lean Six Sigma Pocket Tool Book, by Michael L. George (Percipio)
- Youtube_Opexresources_Nov 27 2015. Introduction to DMAIC