

Continuous Performance Improvement Process

Implementing Lean Six Sigma at a Wastewater Treatment Plant

March 22, 2019

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Agenda

- What is Lean Six Sigma
- LSS Practice in the Industry
- Types of Waste
- Lean Six Sigma Path
- The DMAIC Approach
- CWWTP LSS Projects
- Keys to a Successful Project

What is Lean Six Sigma

- **Lean Six Sigma** is a methodology that relies on a collaborative team effort to improve performance by systematically **removing waste** and **reducing variation**.



Who has Done LSS?

- Toyota
- Allied Signal, General Electric
- IBM, Xerox, EMC, Cessna, Chrysler, Ford
- Nike, Kimberley Clark, Caterpillar, Intel
- Textron, Parker Hannifin, John Deere, HCA
- US Steel, James Moore, Panasonic, Rockwell
- Delphi, DTE Energy, Harley-Davidson
- NYS, Delaware, OK, WA, VA, KY, FL, CA, Tyler, FTW, Dallas, El Paso, Louisville, Savannah, San Diego, DoD, USPS, USAF, US Army, US Navy

Types of Waste

The 8 Wastes

To remember The 8 Wastes, you can use the acronym "DOWNTIME."

D	Defects
O	Overproduction
W	Waiting
N	Non-Utilized Talent
T	Transportation
I	Inventory
M	Motion
E	Extra-Processing



Defects

Efforts caused by rework, scrap, and incorrect information.



Overproduction

Production that is more than needed or before it is needed.



Waiting

Wasted time waiting for the next step in a process.



Non-Utilized Talent

Underutilizing people's talents, skills, & knowledge.



Transportation

Unnecessary movements of products & materials.



Inventory

Excess products and materials not being processed.



Motion

Unnecessary movements by people (e.g., walking).

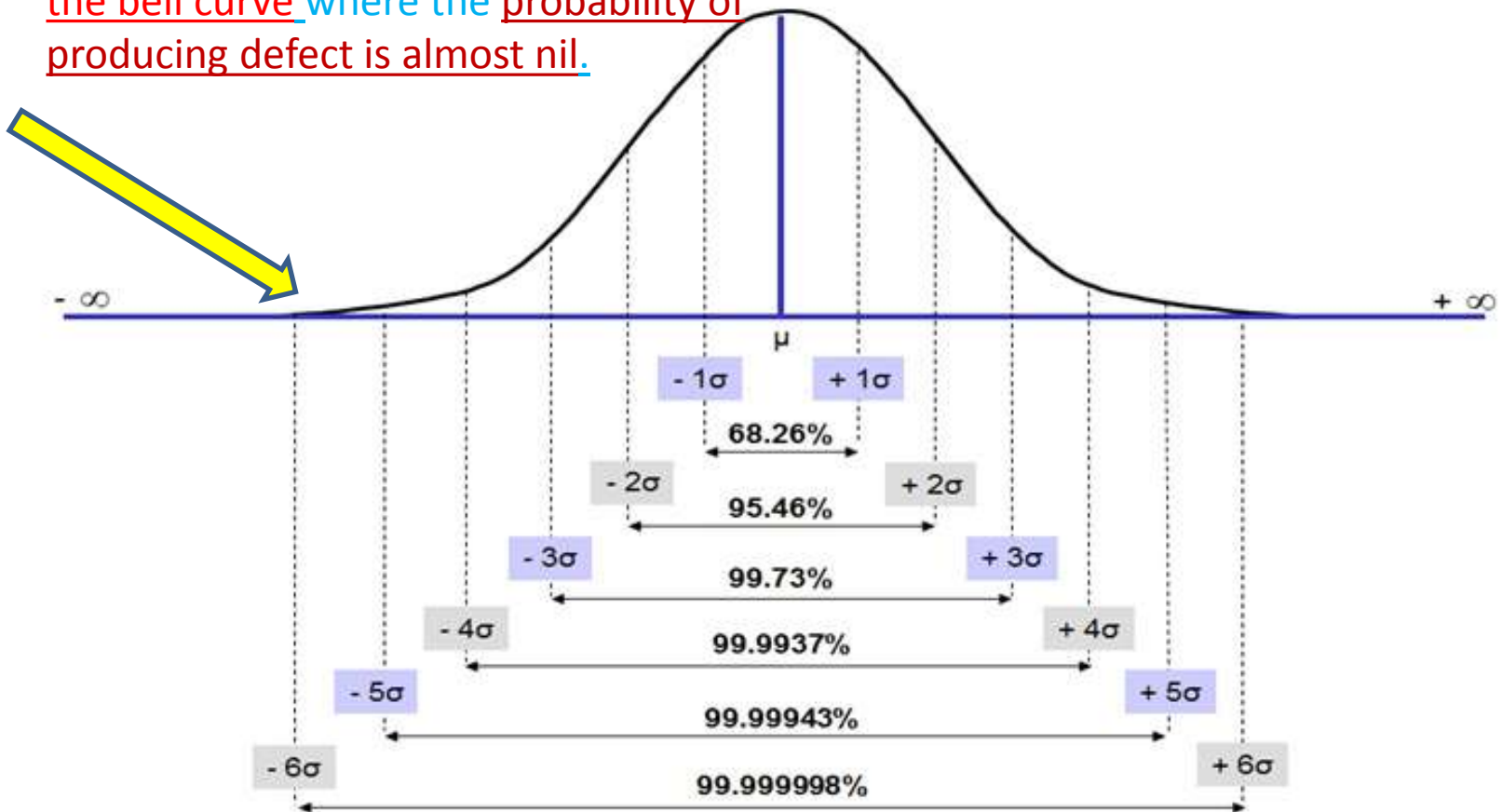


Extra-Processing

More work or higher quality than is required by the customer.

Six Sigma - Statistically

Six Sigma refers to the tiny area under the bell curve where the probability of producing defect is almost nil.



Path of Six Sigma

Sigma Level	DPMO	Yield
1	690,000	30.85 %
2	308,000	69.15 %
3	66,800	93.32 %
4	6,210	99.38 %
5	230	99.97 %
6	3.4	99.99 %

$$DPMO = \frac{1,000,000 \times \text{number of defects}}{\text{number of units} \times \text{number of Defects opportunities per unit}}$$

How to Do It



DMAIC Methodology

Define the problem or goals.

Measure the problem and process where the problem had occurred.

Analyze the data and process to determine root causes of defects.

Improve the process by creating solutions.

Control to implement; sustain the improvements to keep the process going.

The DMAIC Approach...

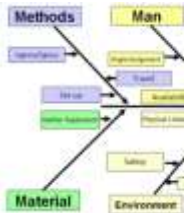
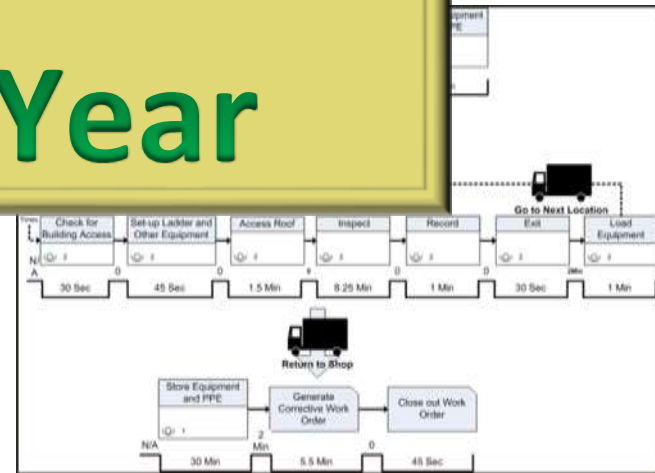
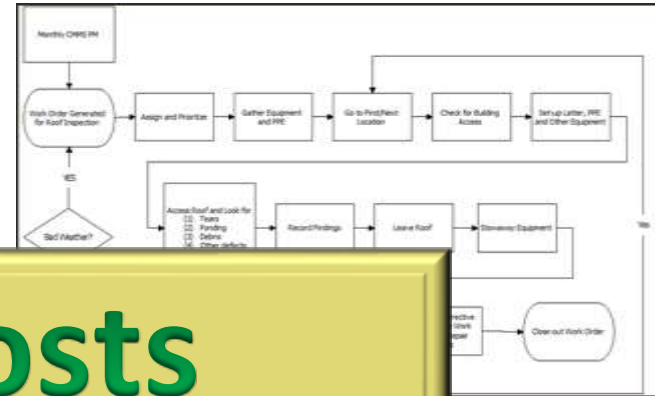


First LSS Project at CWWTP

- Roof Inspections
 - 73 Roof-tops

- 12-14 inspections / Week Scheduled

**Labor Costs
\$31,000/Year**



Attribute Capability

Confidence → 0.95
 Units → 5,041
 Opportunities → 1
 TOP's → 5,041
 Defects → 3,823

Sample data is:
 - Short Term
 - Long Term

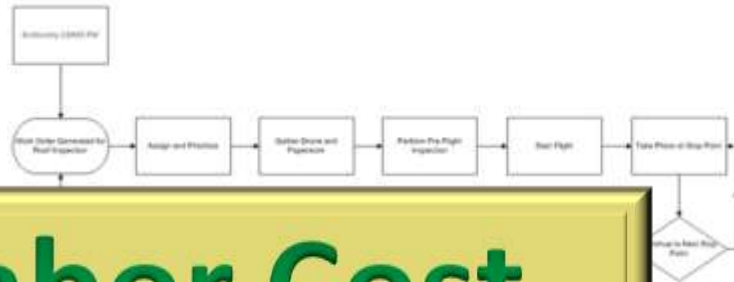
Confidence Interval is:
 - One-sided
 - Two-sided

Long Term Capability						Defects
	σ(σ)	Percent	ppm	Ppk	Z	
Upper Limit on Future State	0.7701	77.0%	770,145	-0.25	-0.74	3682
Specified Value	0.7584	75.8%	758,381	-0.33	-0.70	
Lower Limit on Future State	0.7463	74.6%	746,318	-0.22	-0.68	3762

Estimated Short Term Capability (shifted by 1.5 sigma)

	σ(σ)	Percent	ppm	Cps	Z
Specified Value	0.2122	21.2%	212,176	0.37	0.80

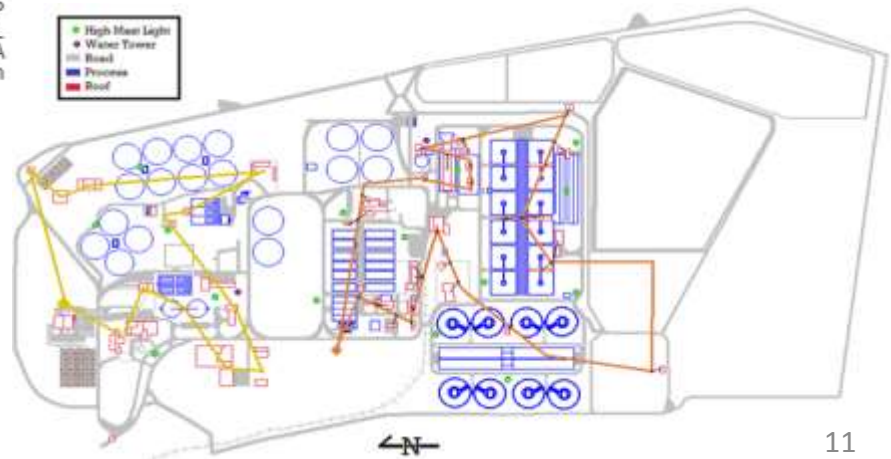
Roof Inspections Using Drone



**New Labor Cost
~\$2,500/Year**

No.	Description	Unit	Rate	Quantity	Amount	Remarks
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
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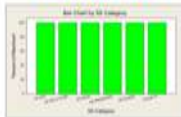
O
L
P
L
A
N



No.	Checking Item	Evaluation Criteria	Score
1	Document Control	Use of necessary documents control and use	0/4 0/1 0/1 0/4 0/4
2	Quality Control	Use any control of inspection document use	0/4 0/1 0/2 0/1 0/4
3	Control Plan	Use the plan in good working condition	0/4 0/1 0/2 0/1 0/4
4	Material Control	Use of material control and storage	0/4 0/1 0/2 0/1 0/4
Sub Total			0/16
Maximum Possible score			100

No.	Checking Item	Evaluation Criteria	Score
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
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A
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D
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T

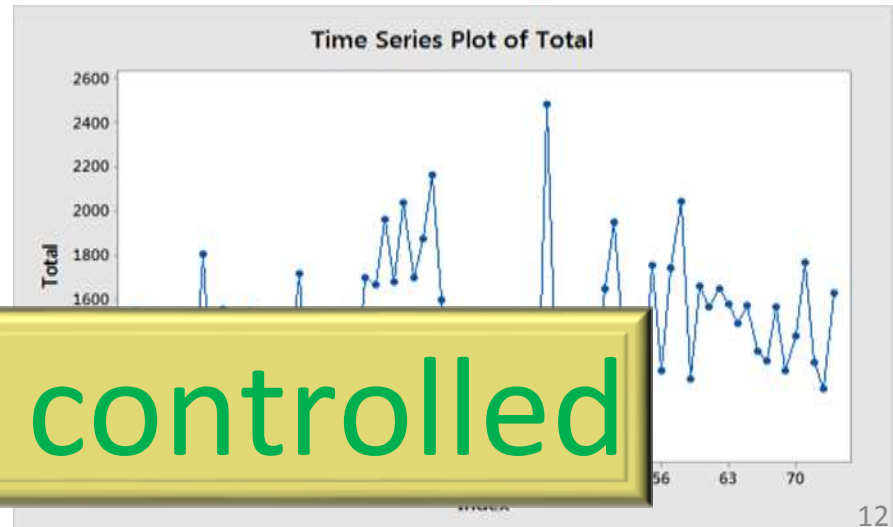
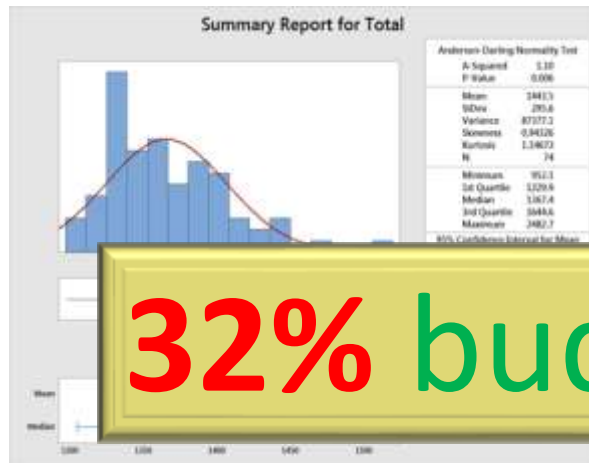


Overtime Control at CWWTP

Problem:

- Hard to manage overtime, thus draining operating budget at a faster pace
- Time reporting different with in every work unit
- Reporting and tracking inefficiencies – no clear standard
- Management reporting delays – cannot take any actions
- Was overtime truly justified ???

66% over budget FY15



32% budget controlled

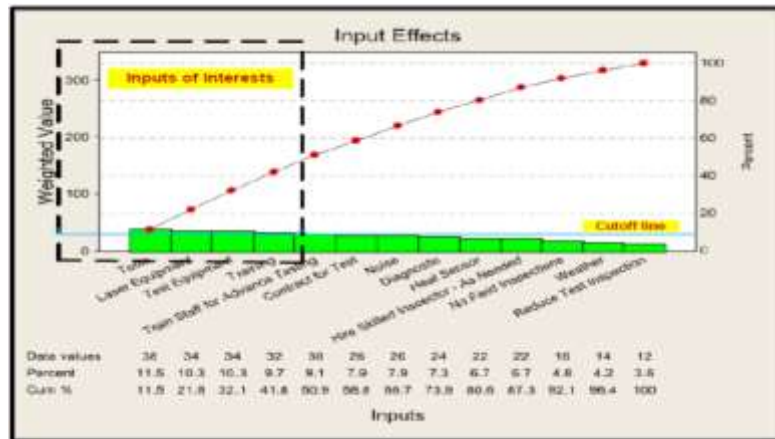
Improving PdM at CWWTP

Predictive Maintenance Program - Evaluated Equipments							
No.	Equipment Name	Equipment Number	Location	Inspection 2014	Inspection 2015	Inspection 2016	Average Inspection
1	Blower - 1	AB7601	Blower Building	48	50	49	49
2	Blower - 2	AB7602	Blower Building	48	49	50	49
3	Blower - 3	AB7603	Blower Building	48	50	48	49
4	Blower - 4	AB7604	Blower Building	48	50	48	49
5	Blower - 5	AB7605	Blower Building	47	50	48	48
6	Non-Pot - 1	EP9101	Non Potable	50	49	49	49
7	Non-Pot - 2	EP9102	Non Potable	48	50	48	49
8	Non-Pot - 3						
9	Non-Pot - 4						
10	Recirc - 1						
11	Recirc - 2						
12	Recirc - 3						
13	Recirc - 4						
14	Recirc - 5						
15	WRPS - 7						
16	WRPS - 8						
17	WRPS - 9						
18	WRPS - 10						
19	WRPS - 11						
20	WRPS - 12						
21	Settle Sewage						
22	Settle Sewage						
23	Settle Sewage						
Total							

Predictive Maintenance Improvement 5S Audit Program

5S	Audit elements	Criteria	Score
SORT	Shelves	Organized, Clean, Labeled	1
	Accessories	Proper location and identified	1
	Tools	Located in proper locations	1
	Obsolete Equipment	Identified and managed	1
	Storage Area	Clean and Organized	1
			5
			5
			1
			1
			68
			5
			1
			1
			60
			5
			1
			1
			66
			5
			1
			50

42% Inspection Reduced



	Before	After	Saving
Number of Inspections	1001	532	469
Man hours	3114	1655	1459
Different Tests Performed	1	4	--
Cost of Inspection	189.74	280.39	--
Cost per Year	\$189,930	\$149,167	\$40,762

Dallas Green Belt Projects

Administered by: **City of Dallas, Center for Performance Excellence**

- **Master Black Belt**
 - + 200 Hours Training
 - Trains and mentors different level belts
- **Black Belt**
 - + 160 Hours Training
 - Leads and completes improvement projects
- **Green Belt**
 - + 80 Hours Training
 - Complete a project
- **Yellow Belt** (8 Hours Training)
- **Blue Belt** (2 Hours Training)

CWWTP LSS Status

- City of Dallas has launched a Lean Six Sigma initiative.
 - 1 – Master Black Belt
 - 2 – Black Belt
 - Over 120 Green Belt Training in the past 4 years
- Central WWTP has 3 Green Belts, 3 on-going projects, and over a dozen Blue/Yellow Belts
- All CWWTP staff have a LSS goal in their performance Plan

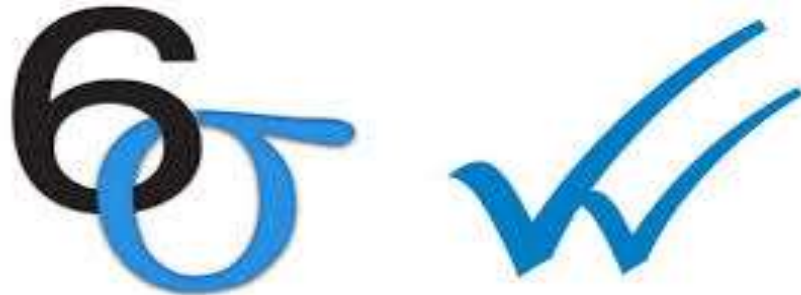
Keys to a Successful Project

- Senior/Executive Management Support
- Team Work, Clear Understanding, Equal Effort
- Data...Lots and Lots of Data
- Diverse Team
 - Open Mind
 - Clean Slate
- Reward
 - Performance appraisal acknowledgement
 - Other monetary or nonmonetary rewards

Continuous Improvement



LEAN SIX-SIGMA



Reference

- www.leansixsigmainstitutu.org
- www.businessofgovernment.org
- Thomas Pyzdek, The Six Sigma Handbook, Oct. 2000.
- Zrymiak, Ramu, Munro, The Certified Six Sigma Green Belt Handbook, 2008.

Q & A

