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Lean Six Sigma Overview

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Objectives

- Understand the origins of Lean
- Understand the origins of Six Sigma
- Understand the synergy of Lean and Six Sigma

Some Take Aways

- A slow value stream (process) is expensive.
- A value stream (process) with a lot of variation is expensive.
- Complex value streams (processes) are expensive.
- Lean is about *velocity* through a value stream (process)
 - A “Lean” value stream is when “value-add” time is more than 20% of the total lead time.
- Six Sigma is about *quality* through a value stream (process)

Lean Six Sigma is the integration of two powerful business improvement approaches



Lean

*Speed + ~~Waste~~ +
Implicit Infrastructure*

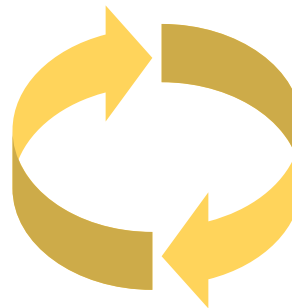
- **Goal** – Reduce waste and increase process speed
- **Focus** – Bias for action/ Implementing Toyota tools
- **Method** – Kaizen events, Value Stream Mapping

Six Sigma

*Quality, Cost + ~~Variation~~
Explicit Infrastructure*

- **Goal** – Improve performance on Customer CTQs
- **Focus** – Use DMAIC with TQM tools to eliminate variation
- **Method** – Management engagement, 1% dedicated as Champions and Black Belts

**Lean Speed Enables
Six Sigma Quality
(Faster Cycles of
Experimentation/Learning)**



**Six Sigma Quality
Enables Lean Speed
(Fewer Defects Means
Less Time Spent on Rework)**

Lean



- Origins in the 1950's at Toyota Motors
- Goals: Henry Ford's low cost, fast lead time, high Quality with Sloane's variety of product
- Toyota achieved these goals by 1980
- Well defined tool set (Pull, Kanban, setup reduction, etc)
- Lean lacked:
 - An implementation infrastructure (1% dedicated Black Belts, etc.)
 - A culture driven by CEO engagement
 - Sustained results
- Results very mixed despite a lot of talk

Mathematical foundation of Lean: Little's Law*



$$\text{The Avg Lead Time of Any Process} = \frac{\text{The Number of "Things" in Process}}{\text{The Avg Completion Rate}}$$



Example:

- The Procurement Department Processes (12) Orders per Hour
- There is a Backlog of (89) unprocessed orders
- A 90th order is put into the queue
- How long must the 90th order wait to be processed?

$$7.5 \text{ Hours} = \frac{90 \text{ Orders in Process}}{12 \text{ Orders per hour}}$$

Lean is a set of tools to reduce the number of things in process without reducing the completion rate

* First proven by Dr. John D.C. Little, MIT, 1961

Lean methods attack waste – “TIMWOOD”

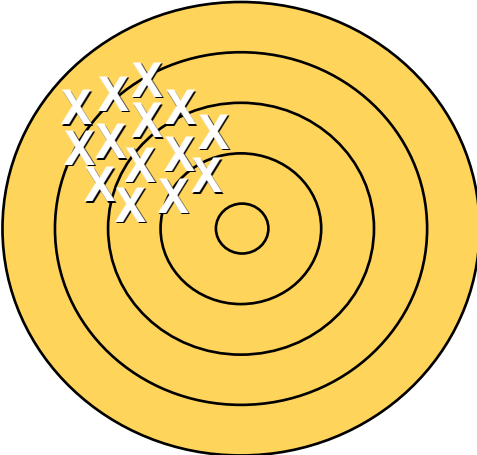


- **T**ransportation – the stuff moves
- **I**nventory – the stuff sits
- **M**otion – the people move
- **W**aiting – the people sit
- **O**verprocessing – adding “value” that the customer doesn’t value
- **O**verproduction – making extra
- **D**efects – all the costs of doing it wrong (scrap, rework, inspection, explanation, etc.)

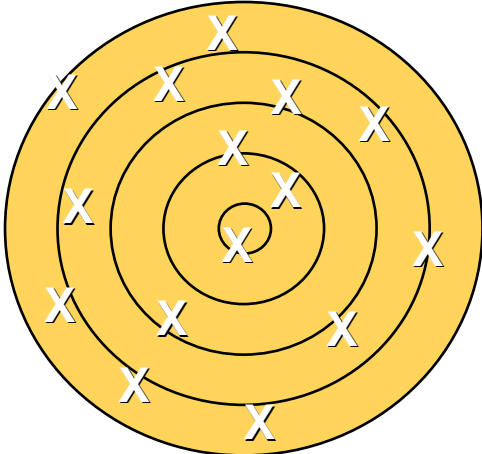
Six Sigma focuses on the elimination of variation



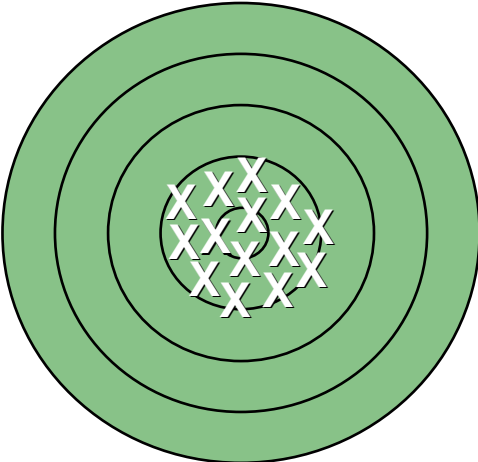
Off-Target



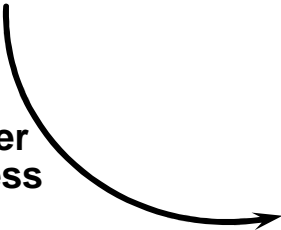
Too Variable



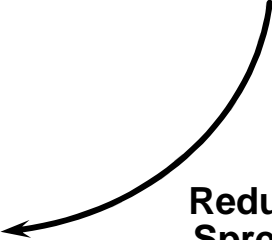
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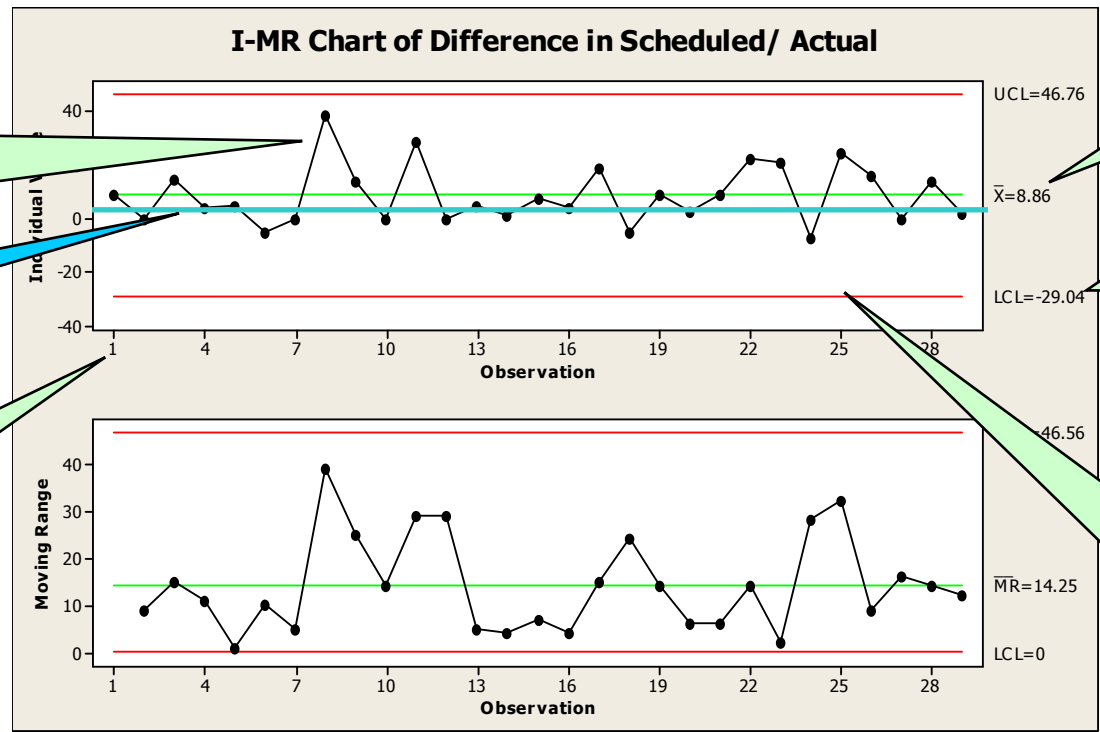
Center Process



Reduce Spread



Example of Variation in a Value Stream (Process)



1. Each data point represents the difference between the actual and scheduled time

Line marks +3 minutes late

2. These points are in time sequence

3. On average the asset will arrive +8.8 minutes late

4. We can predict that overall these assets will arrive between 29 minutes early and 47 minutes late

5. This is a predictable process. No data point is above or below the red lines and the data between the lines does not have a pattern over time.

- This is an expensive value stream (process)
- If the line marked +3 minutes late is a customer “specification”, this process will not meet it.
- The value stream (process) must be changed to shift the mean and the control limits (control limits are NOT specifications)

Sigma Quality Level Conversion Table

An indicator of quality and variation

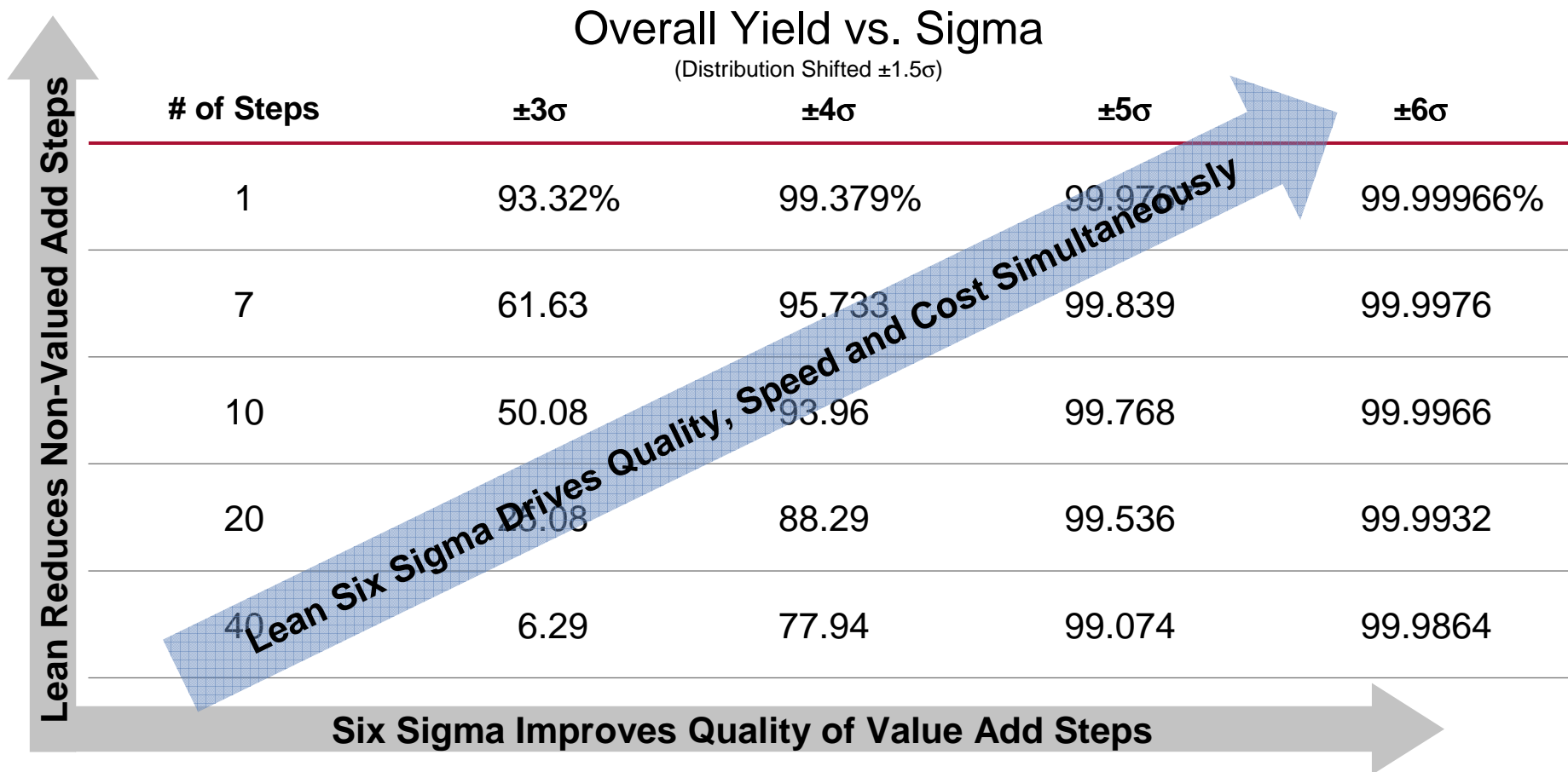


Yield	DPMO	Sigma	Yield	DPMO	Sigma	Yield	DPMO	Sigma
6.6%	934,000	0	69.2%	308,000	2	99.4%	6,210	4
8.0%	920,000	0.1	72.6%	274,000	2.1	99.5%	4,660	4.1
10.0%	900,000	0.2	75.8%	242,000	2.2	99.7%	3,460	4.2
12.0%	880,000	0.3	78.8%	212,000	2.3	99.75%	2,550	4.3
14.0%	860,000	0.4	81.6%	184,000	2.4	99.81%	1,860	4.4
16.0%	840,000	0.5	84.2%	158,000	2.5	99.87%	1,350	4.5
19.0%	810,000	0.6	86.5%	135,000	2.6	99.90%	960	4.6
22.0%	780,000	0.7	88.5%	115,000	2.7	99.93%	680	4.7
25.0%	750,000	0.8	90.3%	96,800	2.8	99.95%	480	4.8
28.0%	720,000	0.9	91.9%	80,800	2.9	99.97%	330	4.9
31.0%	690,000	1	93.3%	66,800	3	99.977%	230	5
35.0%	650,000	1.1	94.5%	54,800	3.1	99.985%	150	5.1
39.0%	610,000	1.2	95.5%	44,600	3.2	99.990%	100	5.2
43.0%	570,000	1.3	96.4%	35,900	3.3	99.993%	70	5.3
46.0%	540,000	1.4	97.1%	28,700	3.4	99.996%	40	5.4
50.0%	500,000	1.5	97.7%	22,700	3.5	99.997%	30	5.5
54.0%	460,000	1.6	98.2%	17,800	3.6	99.9980%	20	5.6
58.0%	420,000	1.7	98.6%	13,900	3.7	99.9990%	10	5.7
61.8%	382,000	1.8	98.9%	10,700	3.8	99.9992%	8	5.8
65.6%	344,000	1.9	99.2%	8,190	3.9	99.9995%	5	5.9
						99.99966%	3.4	6

Six Sigma improves quality; Lean eliminates non-value add steps in the value stream

A 10% defect rate increases lead times by 38% and WIP by 53%

Both are required to reduce the cost of process complexity



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