

Air  
Land  
Sea  
Space  
Cyberspace

Innovation. In all domains.

# Everything You Wanted to Know About CMMI® and Six Sigma but Did Not Know Who to Ask

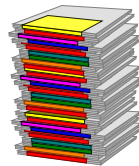
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November, 2009

- **QUICK Introduction to Six Sigma**
- **Relationship of Six Sigma to the CMMI**
- **Applying Six Sigma**
- **Examples of Six Sigma Tool Usage to Improve**



BlackBelt training is 160 hrs



Intro to CMMI is 24 hrs



**I have 30 Minutes**

# What Do You Think Six Sigma Is All About?

Benchmark?

Metric?

Method?

Philosophy?

Vision?

Pipe Dream?

Disease?

Stretch Goal?



# What Is Six Sigma?

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A customer-driven management methodology to significantly increase **customer** satisfaction through reducing and eliminating variation and thus defects.

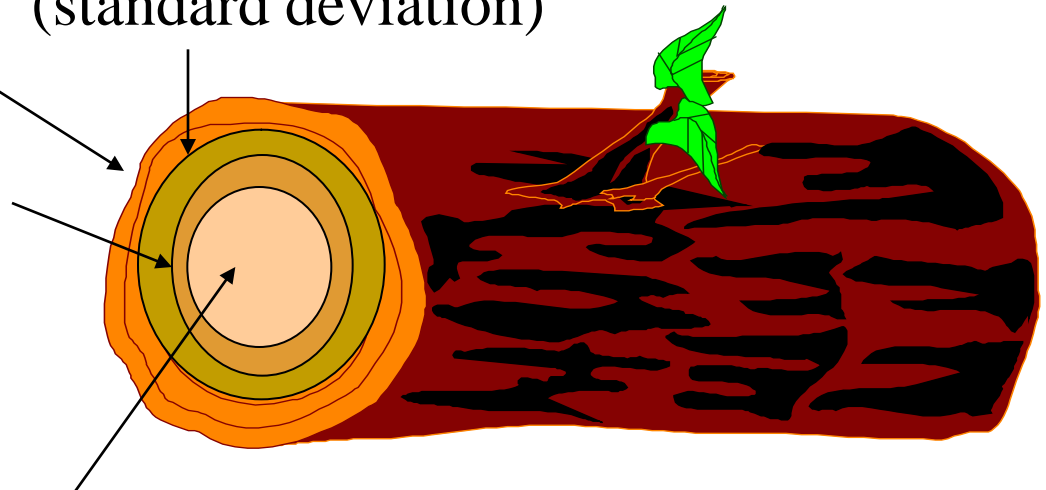
A concept developed by Motorola to achieve a desired level of quality, virtually defect-free products and processes

With this definition, six sigma is applicable to any development or manufacturing process

**Sigma** is a letter in the Greek alphabet

“**Sigma**” is used to designate the distribution about the mean of any process or product characteristic (standard deviation)

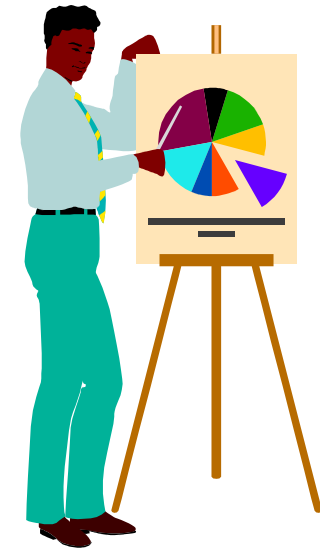
“**Sigma value**” indicates how often defects are likely to occur



“**Sigma level**” is the number of standard deviations between the process center and the CLOSEST spec limit

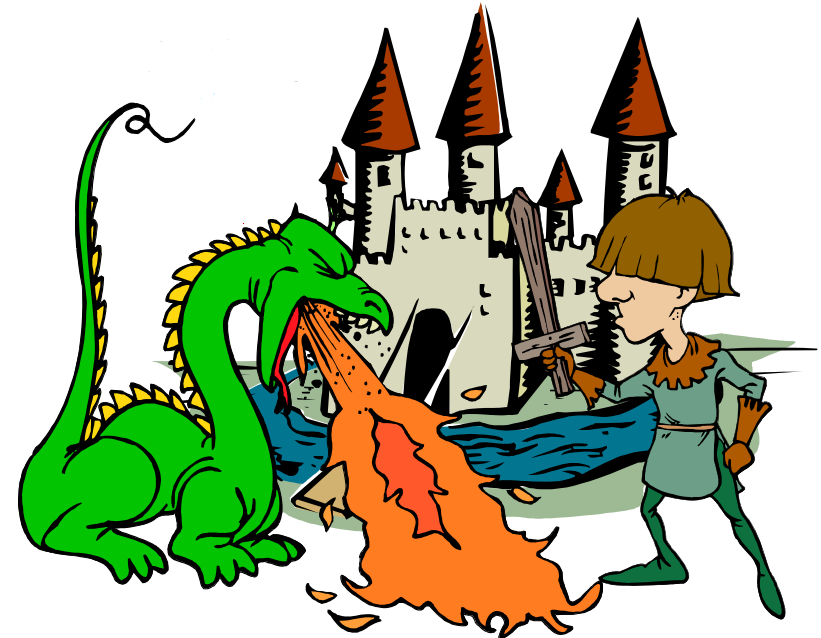
# Premise for Six Sigma

- Sources of **variation** can be
  - Identified
  - Quantified
  - Mitigated by control or prevention
- The elements of a process responsible for variation are called the “6 M’s”
  - Man (people)
  - Machine
  - Material
  - Method
  - Measurement
  - Mother Nature



# Variation is the Enemy

- Variation exists in everything
- If it is assumed that everything is a result of some process, then it is safe to conclude that the process introduces product variation
- Variation in the product is due to variation in the process
- Variation comes in two forms - **common** and **special cause**



We Must Slay the Enemy

# Common and Special Causes

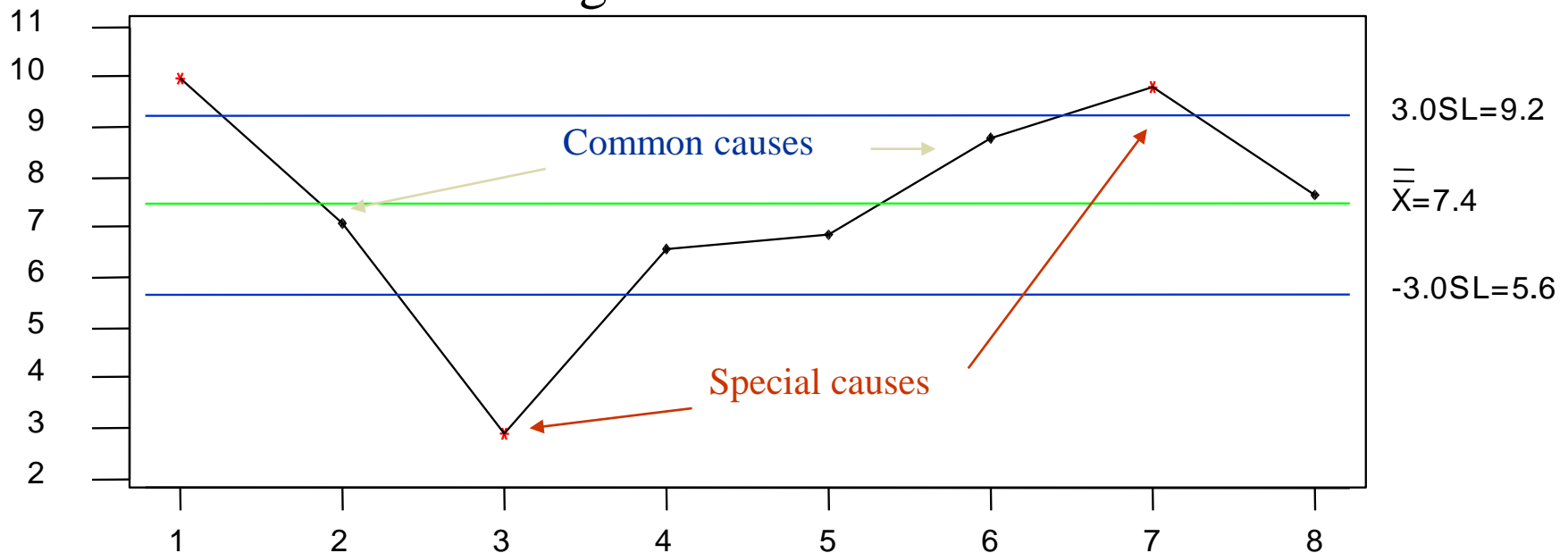
## Common Causes

- Continuously active in the process
- Predictable

## Special Cause

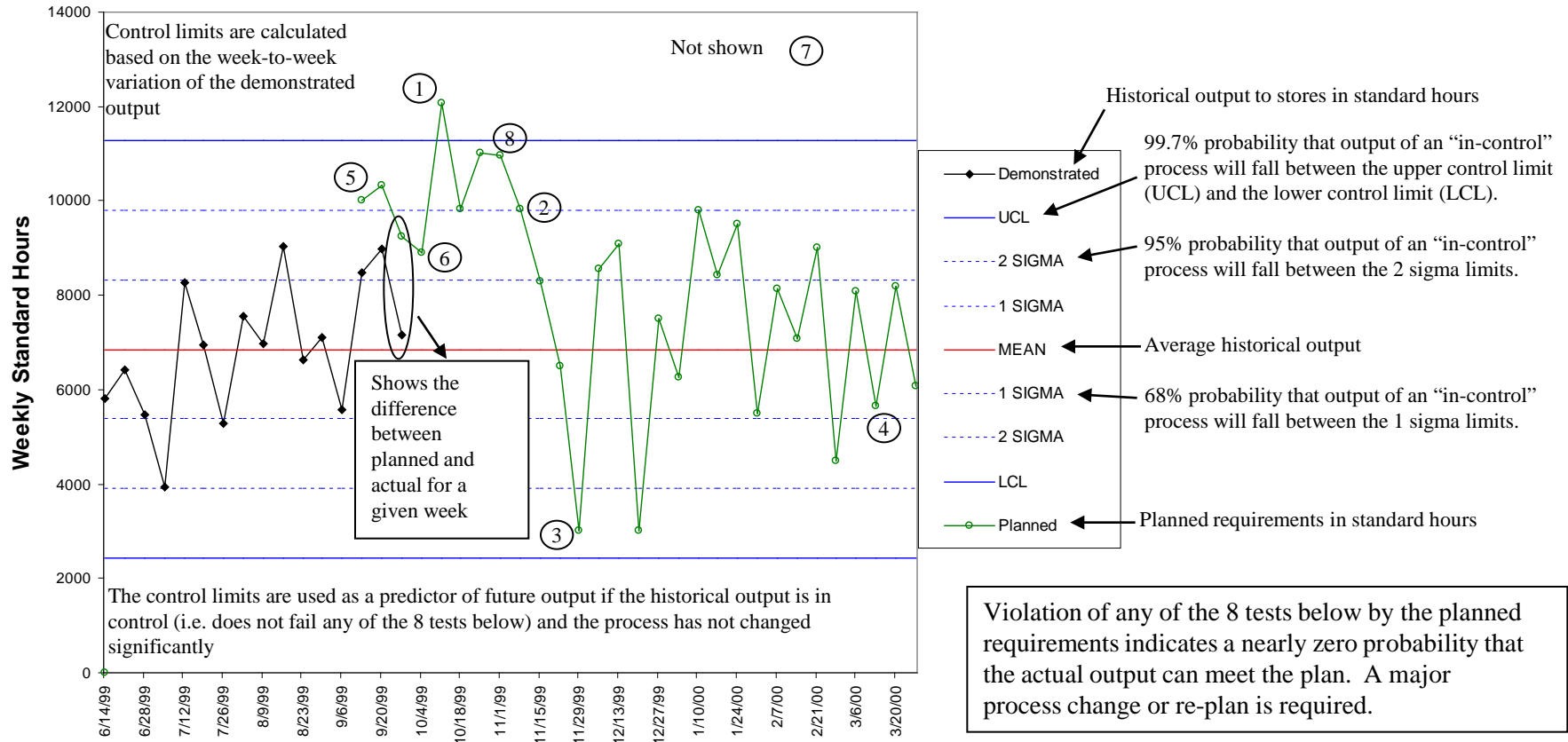
- Extraordinary events
- Can assign a reason
- Can do something about it

Control limits are not to be confused with specification limits for a specific characteristic





# Reading a Control Chart



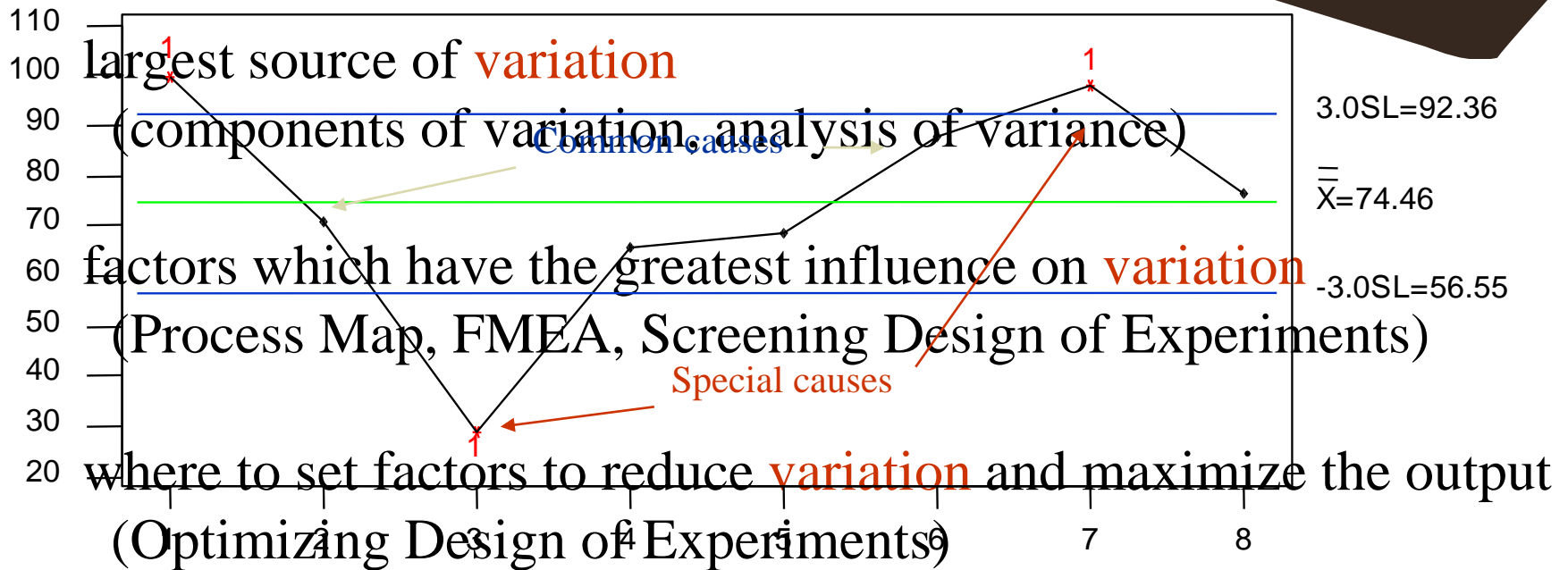
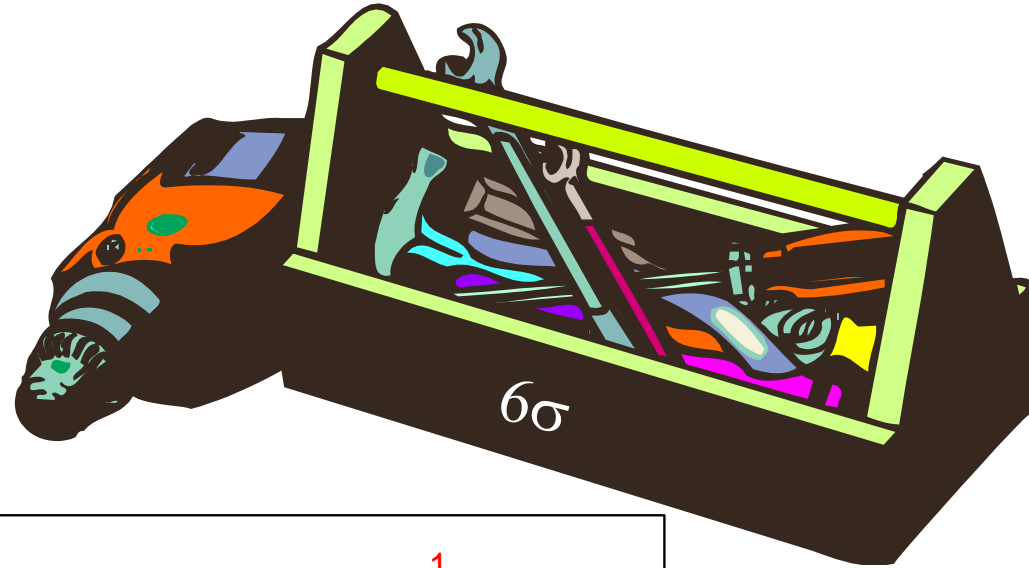
## Tests for out-of-control conditions in a control chart

- ① One point more than three sigmas from the mean
- ② Nine points in a row on the same side of the mean
- ③ Six points in a row all increasing or decreasing
- ④ Fourteen points in a row, alternating up and down
- ⑤ Two out of three points more than 2 sigmas from the mean
- ⑥ Four out of five points more than 1 sigma from the mean
- ⑦ Fifteen points in a row within 1 sigma of the mean
- ⑧ Eight points in a row more than 1 sigma from the mean

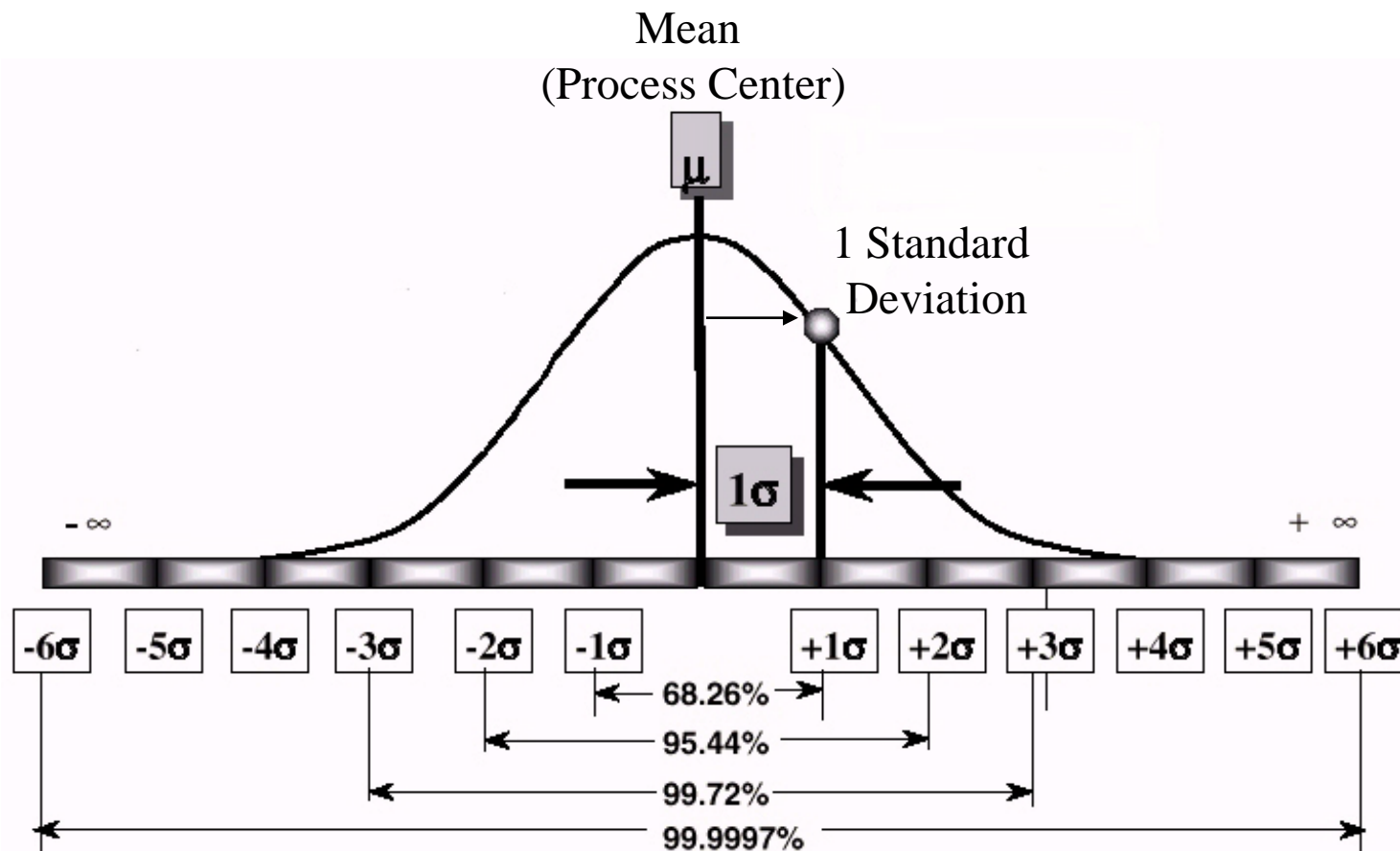
# Six Sigma is All About Variation

Six Sigma tools help identify

types of **variation**  
(control chart)

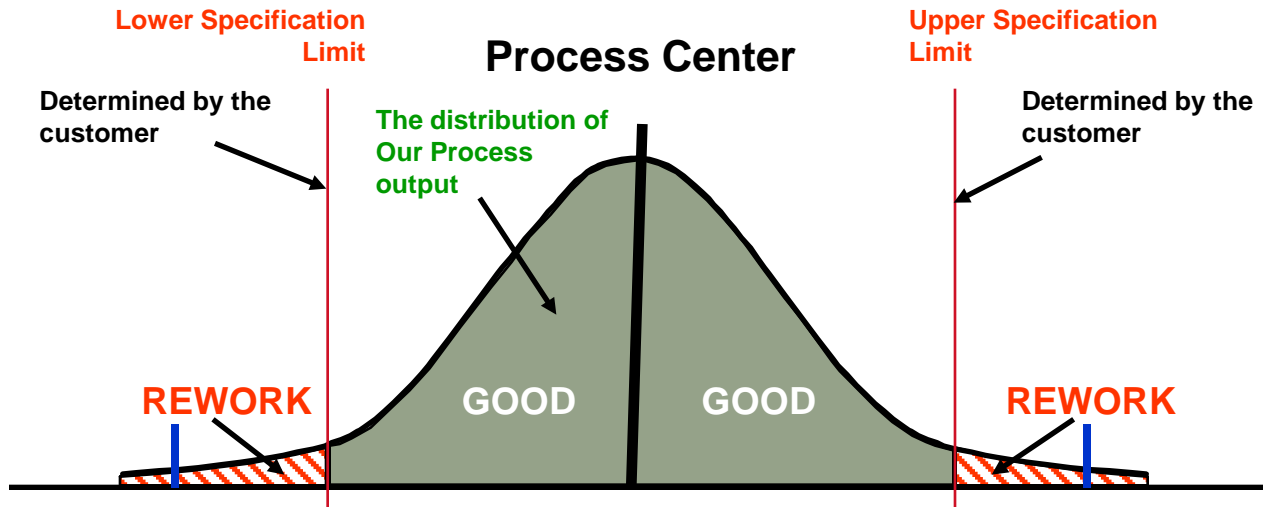


# Six Sigma is Based on Statistics



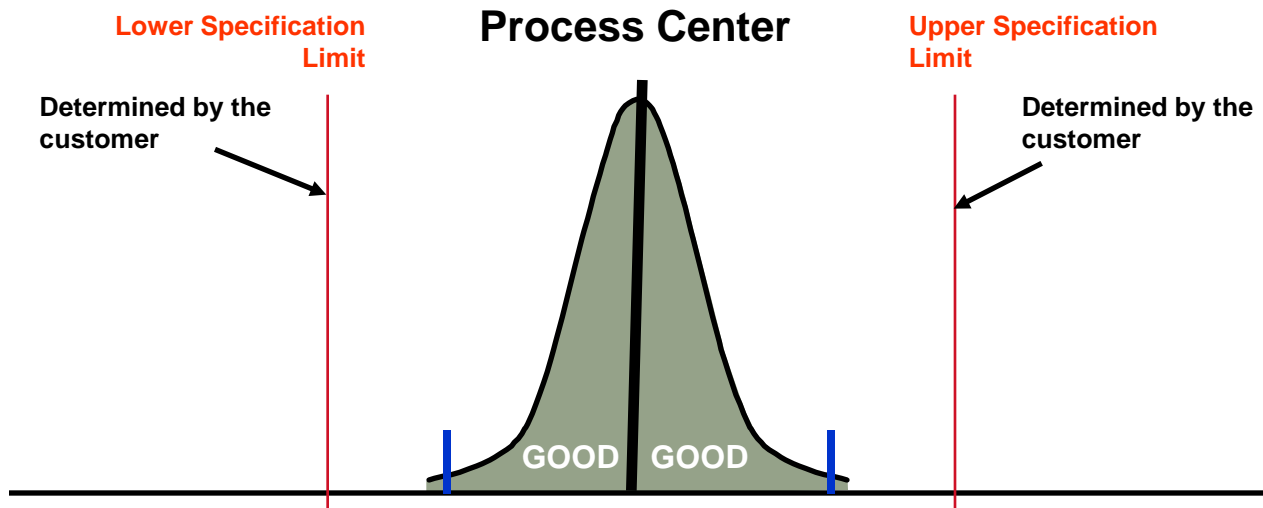
**Remember - no statistics today**

# States of a Process



## Incapable Process

- We have **REWORK** because some of what we make is waste
- Process is **WIDER** than the specification limits

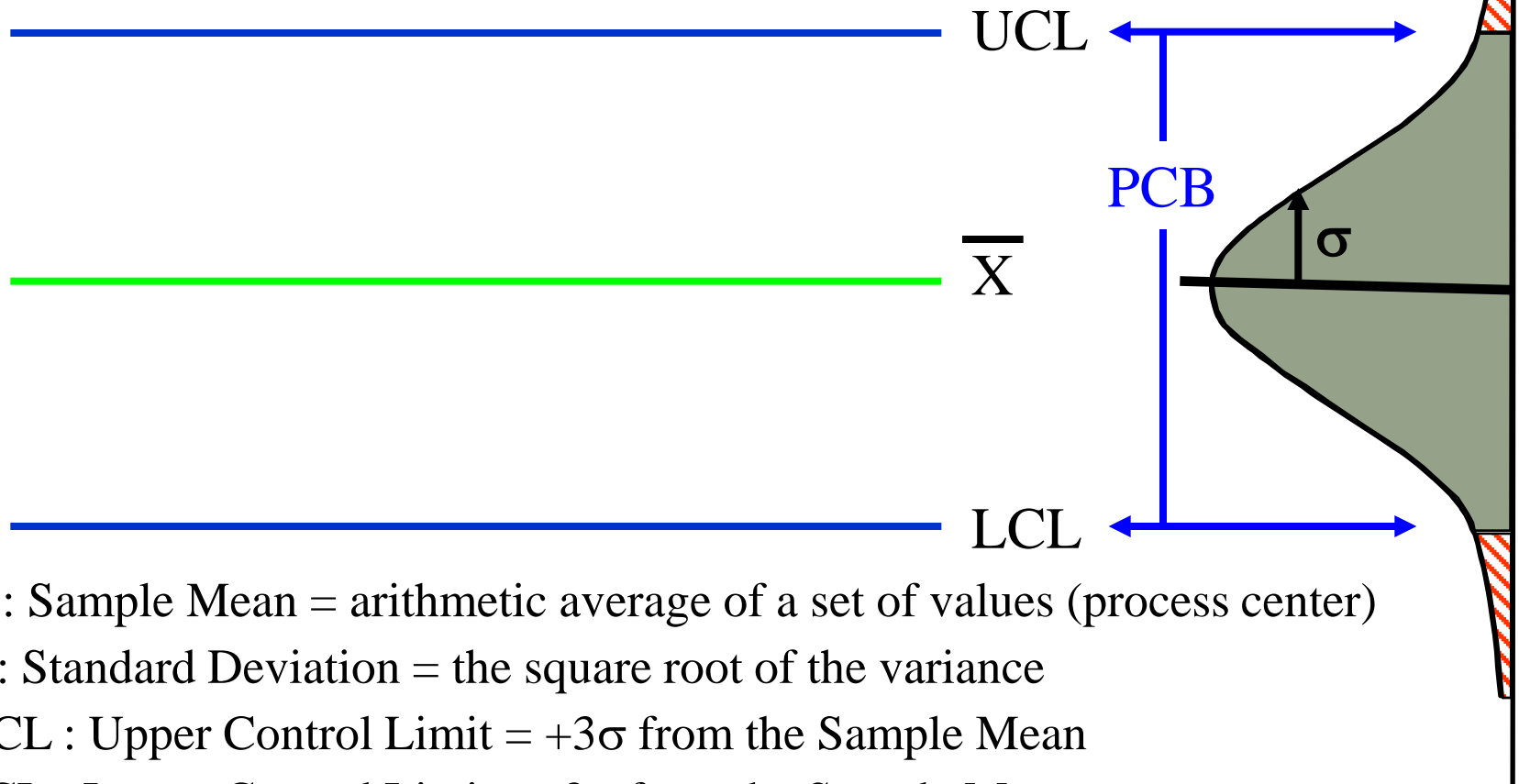


## Capable Process

- We make as much as the customer needs and have very little waste
- Process **FITS** within the specification limits

# X Bar What? Standard Who?

If you take the bell shaped curve and turn it on its side, you have a control chart



$\bar{X}$  : Sample Mean = arithmetic average of a set of values (process center)

$\sigma$  : Standard Deviation = the square root of the variance

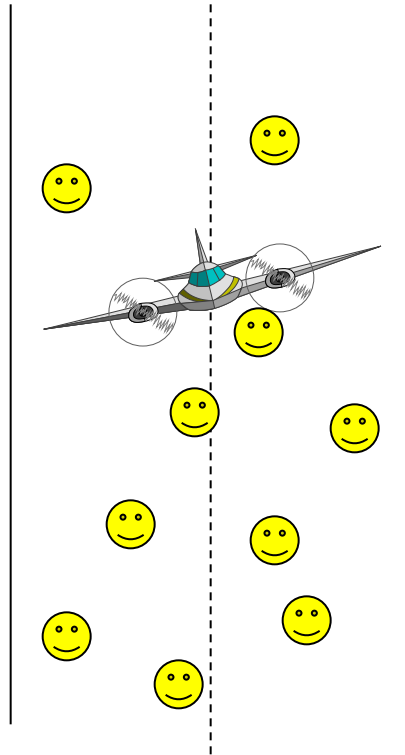
UCL : Upper Control Limit =  $+3\sigma$  from the Sample Mean

LCL : Lower Control Limit =  $-3\sigma$  from the Sample Mean

PCB : Process Capability Baseline = “normal” variation for the sample

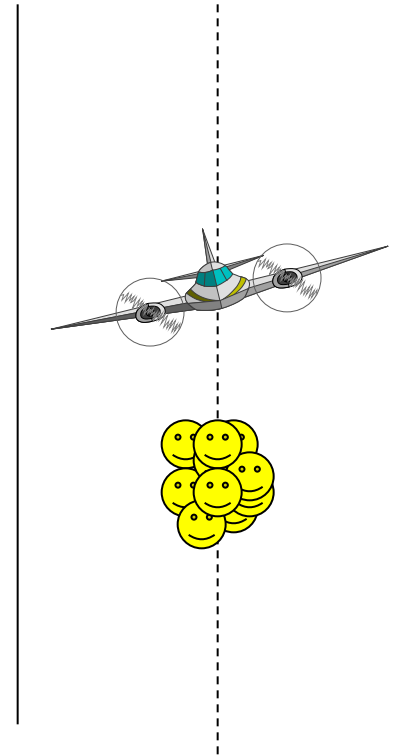
# So Long As We Satisfy the Requirements, **Raytheon** Right?

## Pilot A



Both within spec,  
same average landing

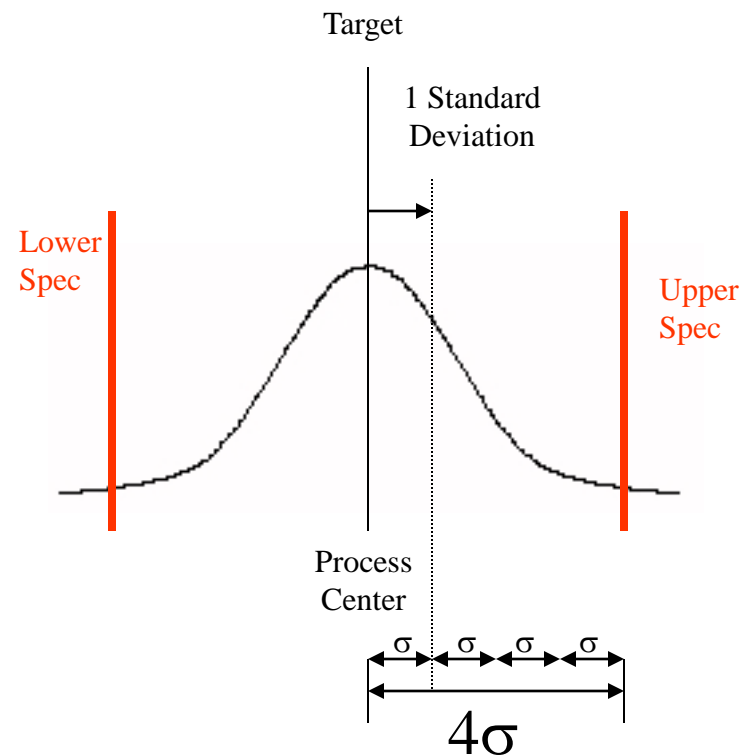
## Pilot B



Which pilot would you want to fly with? Why?

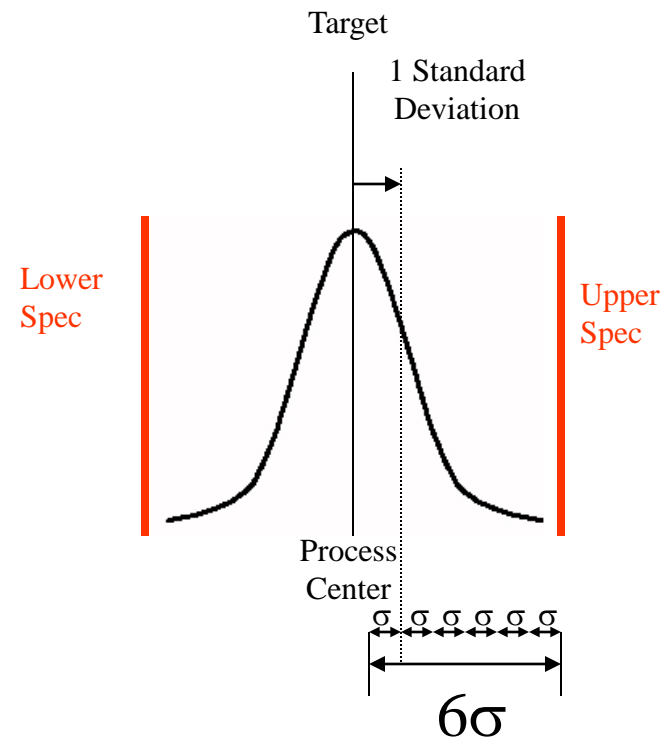
# Moving Towards Six Sigma

## Pilot A's Distribution



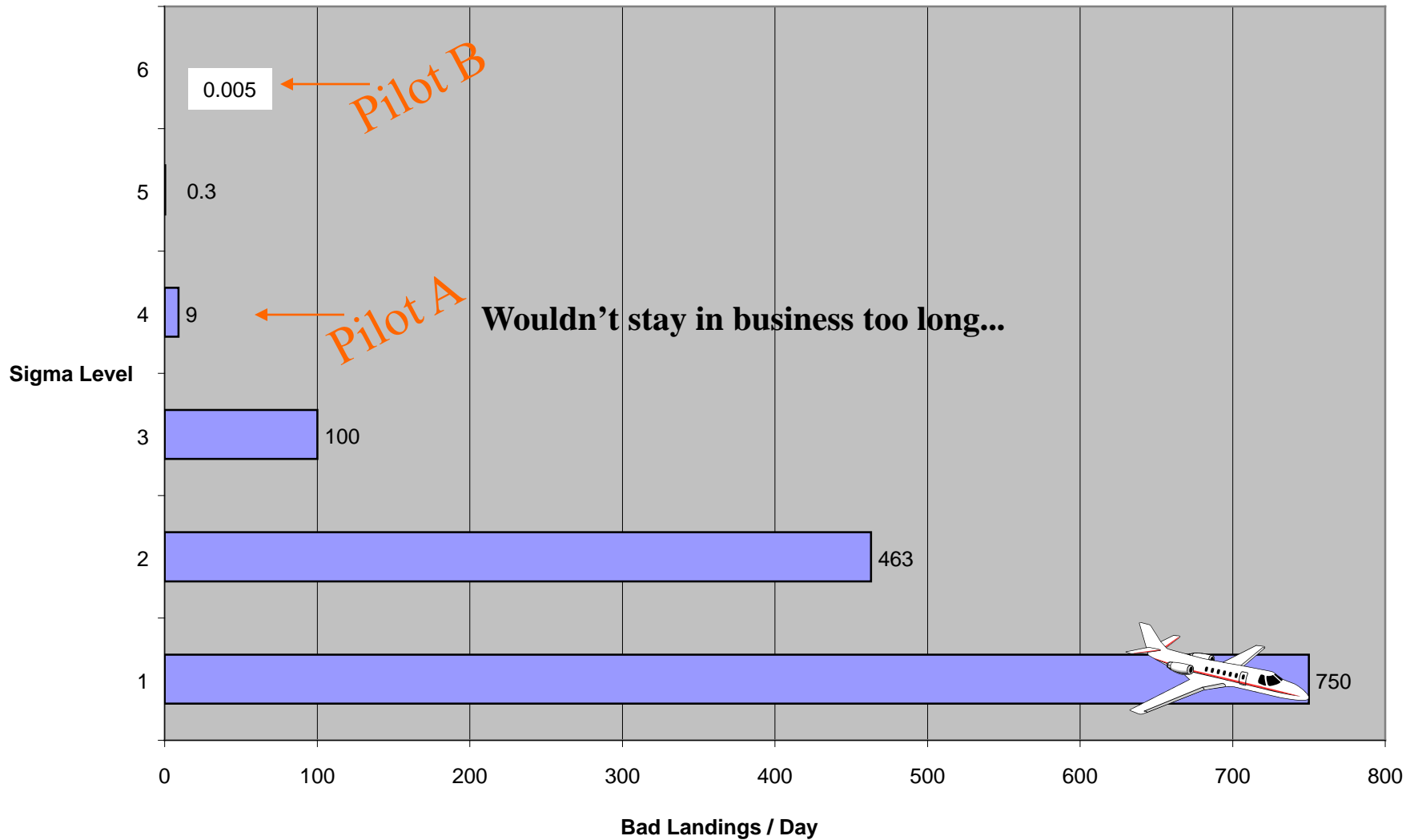
Pilot A is at 4 sigma

## Pilot B's Distribution



In order to be six sigma, like Pilot B, the variation in Pilot A's landings must be reduced

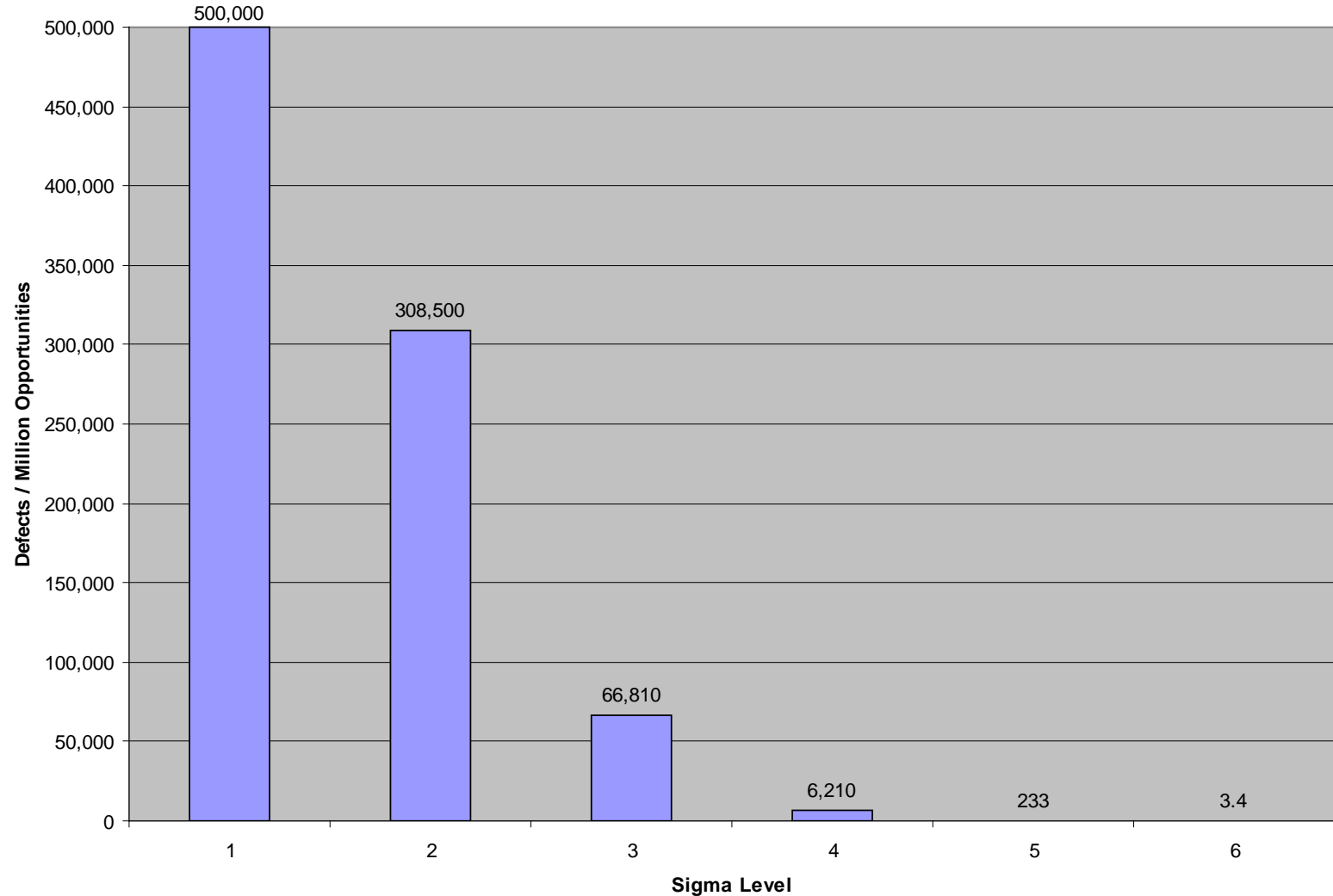
# Pilot A and B at Sky Harbor Airport



Wouldn't stay in business too long...



# Higher Sigma Equates to Major Reduction in Defects



# Six Sigma -The Other Story

**1 $\sigma$**  - 170 misspelled words per page in a book

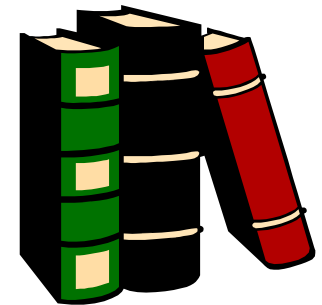
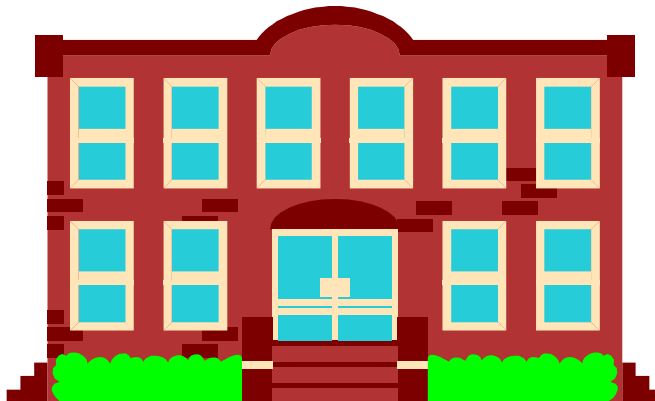
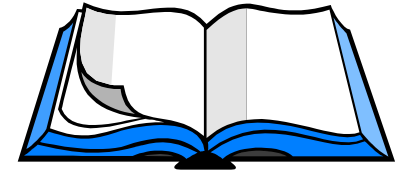
**2 $\sigma$**  - 25 misspelled words per page

**3 $\sigma$**  - 1.5 misspelled words per page

**4 $\sigma$**  - 1 misspelled word per 30 pages

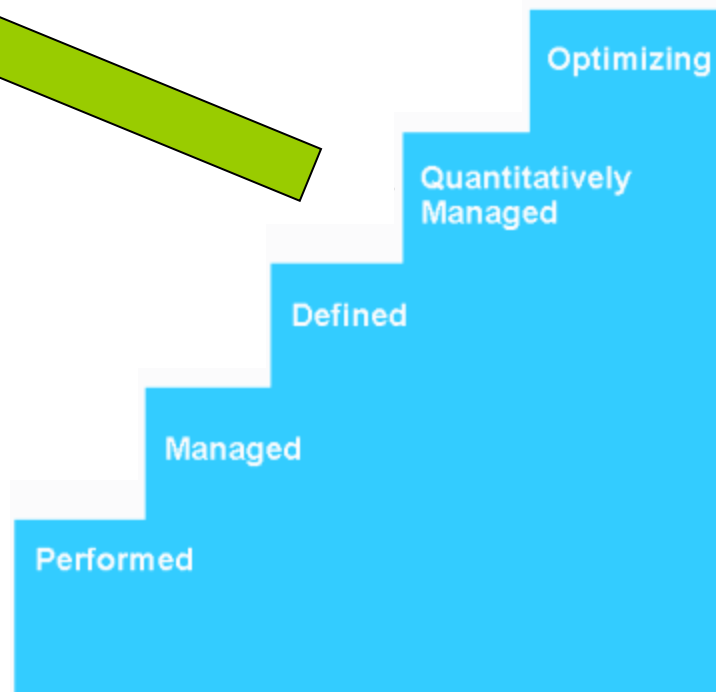
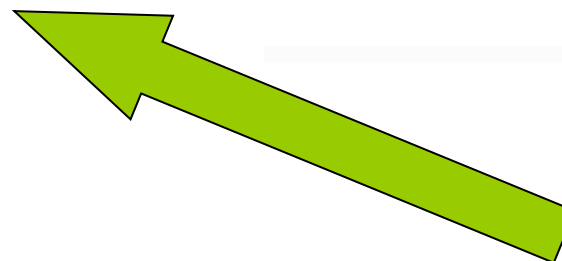
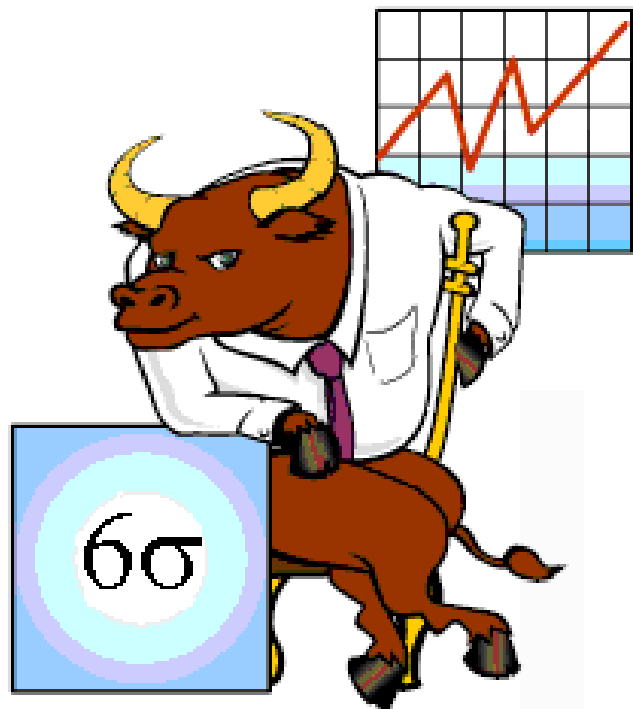
**5 $\sigma$**  - 1 misspelled word in a set of encyclopedias

**6 $\sigma$**  - 1 misspelled word in all the books in a library

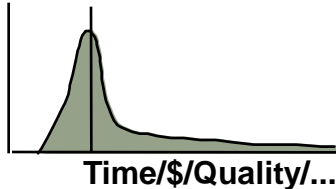
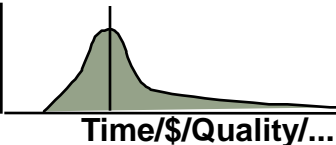
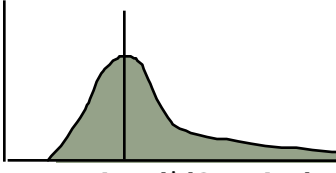
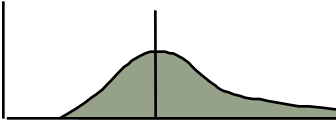


**Understand you customers' needs  
And balance with cost**

# CMMI Meets Six Sigma



# CMMI Reminder

Maturity Level		Predicted Performance
<p><b>5</b> Optimizing</p>	<p>the organization concentrates on quantitatively improving the process to maximize the achievement of the organization's and projects' goals</p>	 <p>Time/\$/Quality/...</p>
<p><b>4</b> Quantitatively Managed</p>	<p>all the process assets accumulated from Level 2 and 3 are used to quantitatively understand the process performance</p>	 <p>Time/\$/Quality/...</p>
<p><b>3</b> Defined</p>	<p>the organization has a defined common process which includes the collection of common product and process metrics</p>	 <p>Time/\$/Quality/...</p>
<p><b>2</b> Managed</p>	<p>the best practices reside in the projects</p>	 <p>Time/\$/Quality/...</p>

## Level 2 - Measuring the Project

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The initial focus for measurement activities is at the project level. As the organization moves toward Level 3, common measures are defined which prove useful for addressing organization and/or enterprise-wide information needs.

# Level 3 – Understanding the Organizational Practices

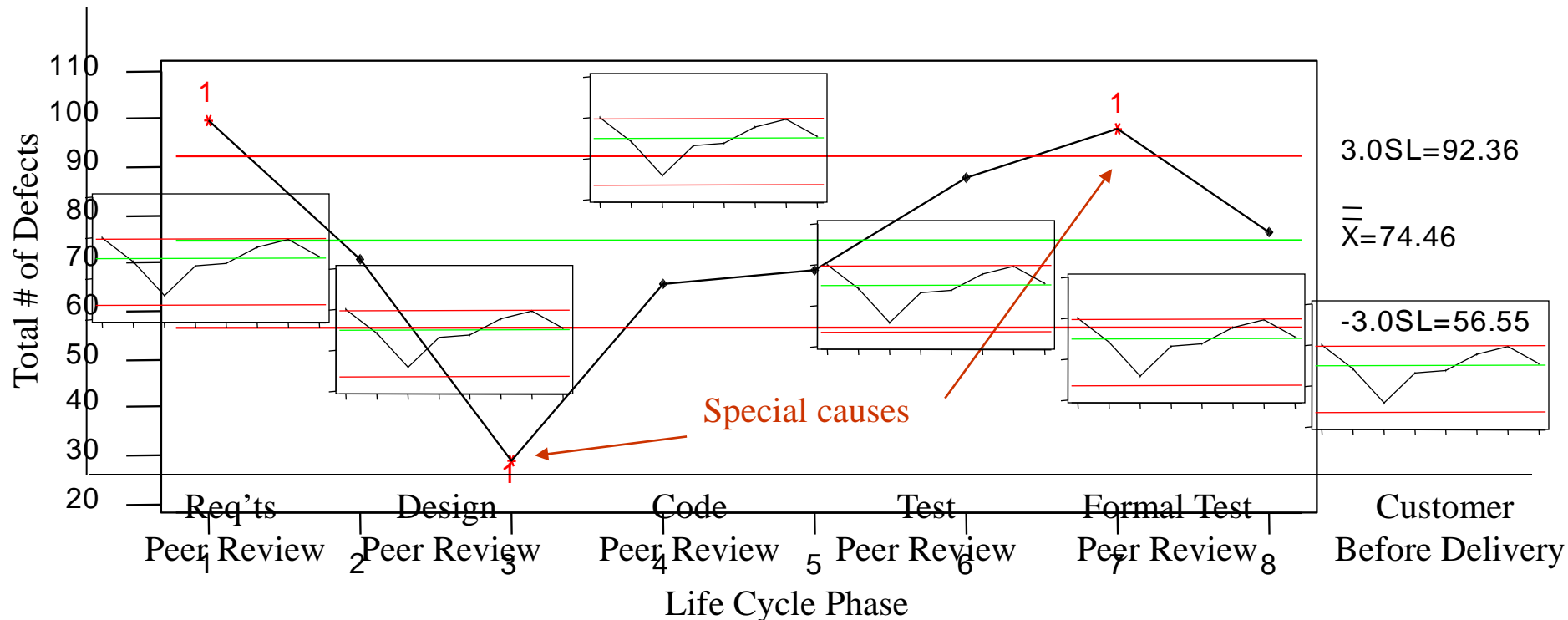
At Level 3, project data is collected and analyzed across the organization. Thresholds may be set based on good engineering judgment which trigger corrective action

Level 2/3 set the stage for quantitative and statistical management

- Repeatable, Consistent Processes
- Adequate Resources
- Defined, Consistent Process Measures
- Data Collected From Above Process
- Assurance of Process Compliance

# Level 4 – Characterizing and Stabilizing the Process

At maturity level 4, quantitative and statistical techniques are used to manage process performance and product quality. Quality and process performance is understood in statistical terms. Special causes of process variation are identified and, where appropriate, the sources of special causes are corrected to prevent future occurrences.



# Level 4 – Characterizing and Stabilizing the Process

When performance falls outside normal range of process performance

- Identify the reason
  - Take corrective action when appropriate

A critical distinction between maturity level 3 and 4 is the predictability of process performance. At maturity level 4, the performance of processes is quantitatively predictable and controlled using statistical and other quantitative techniques

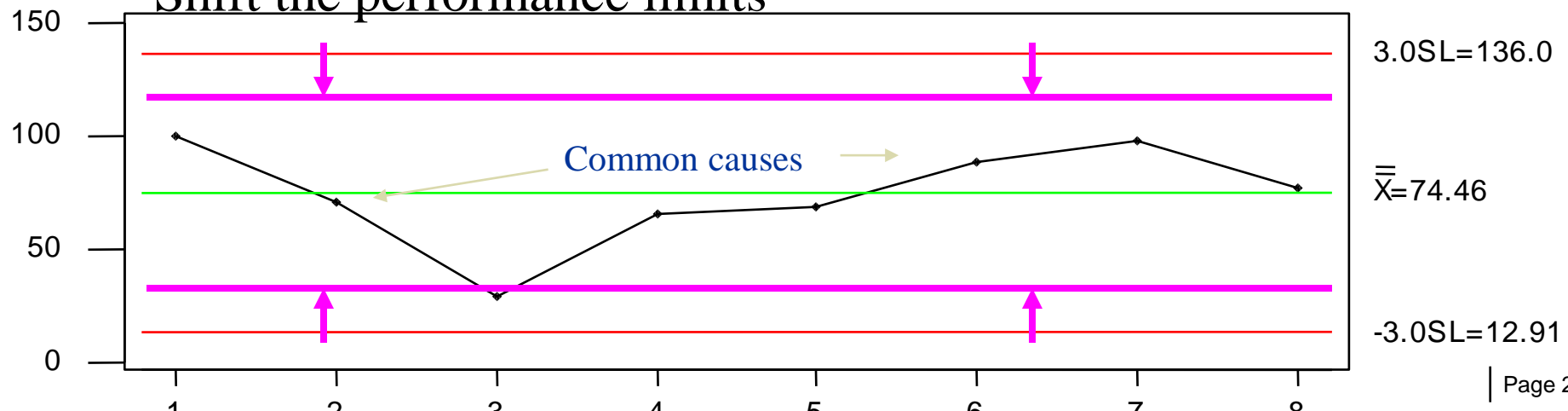


# Level 5 - Optimizing the Process

At maturity level 5, an organization continually improves its processes based on a quantitative understanding of the common causes of variation inherent in processes to maximize the probability of achieving its goals

When performance is within normal range of process performance but unable to meet the established objectives

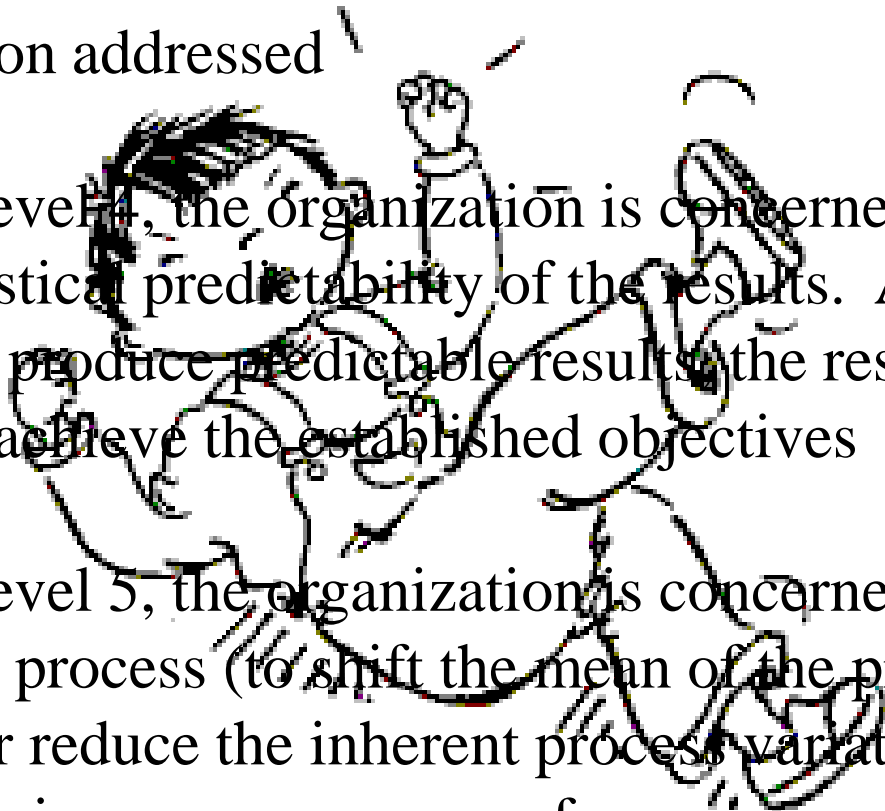
- Narrow the performance limits
- Shift the performance limits



# Am I Acting 4 or 5?

A critical distinction between levels 4 and 5 is the type of process variation addressed

- At maturity level 4, the organization is concerned with providing statistical predictability of the results. Although processes may produce predictable results, the results may be insufficient to achieve the established objectives
- At maturity level 5, the organization is concerned “bumping” the process (to shift the mean of the process performance or reduce the inherent process variation experienced) to improve process performance and to achieve the established quantitative process-improvement objectives

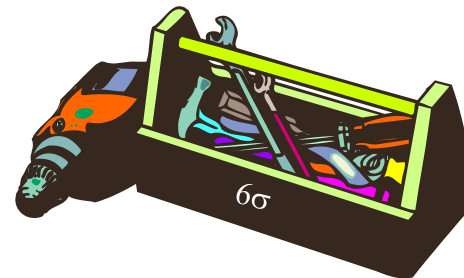


# Six Sigma Tools Enable Levels 4 and 5

Six Sigma methodology provides the tools that enable high maturity

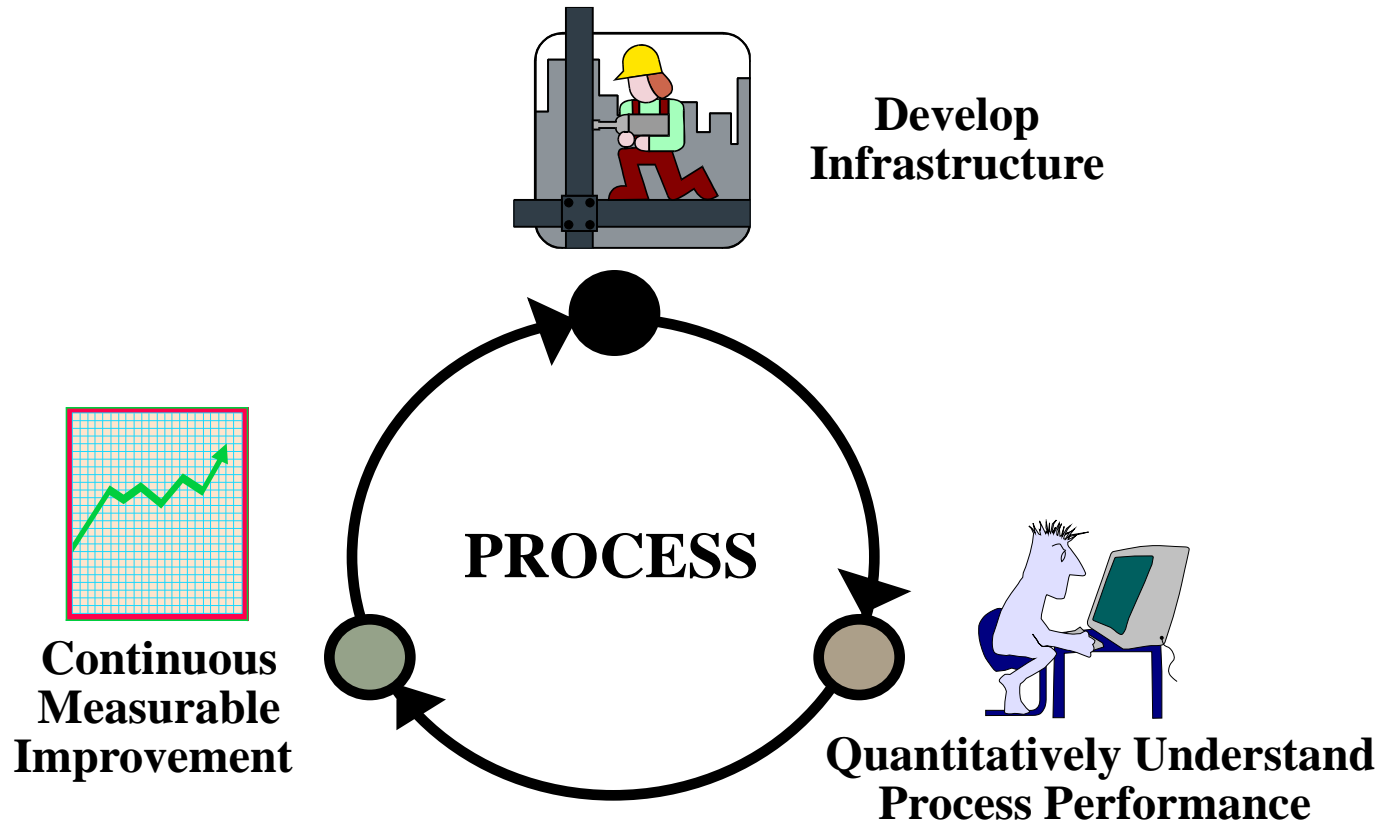
- **Quantitative Project Management,**
- **Organization Process Performance**
- **Causal Analysis and Resolution**
- **Organizational Innovation and Deployment**

CMMI provides a “process wrapper” to effectively and efficiently use the Six Sigma toolbox



A Level 5 organization is one that has implemented, among other things, statistical management

# Applying Six Sigma



# Develop Infrastructure

## • Commitment to Process Improvement

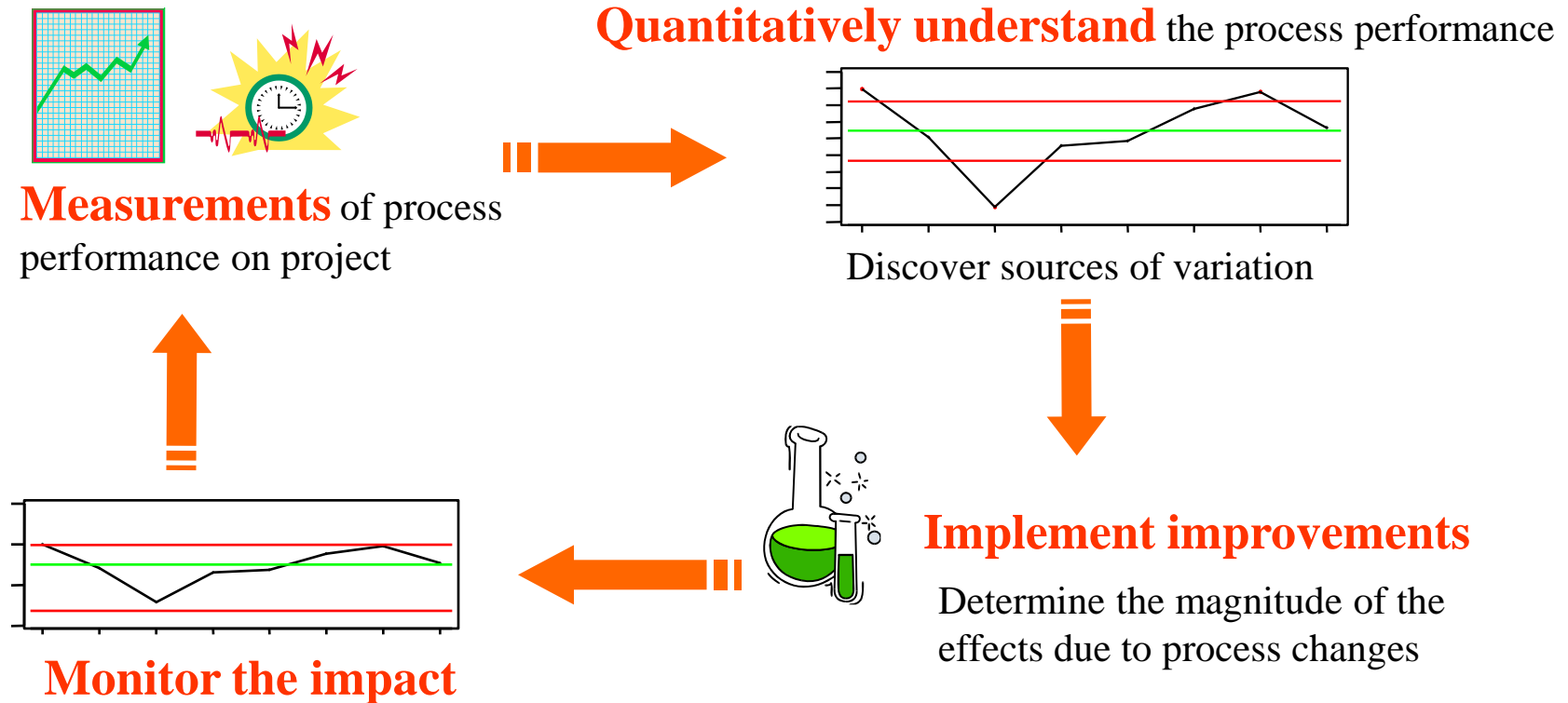
- Repeatable, Consistent Process
- Adequate Resources
- Defined, Consistent Process Measures
- Data Collected From Above Process
- Assurance of Process Compliance



Only required for  
the window you are  
looking through

# Quantitatively Understand Process Performance

Use Six Sigma tools to identify sources of variation (quantitatively understand process performance) and then act to eliminate or reduce those sources

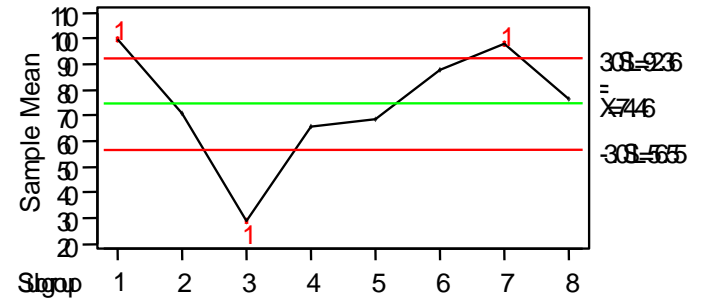


# Six Sigma – Real Life Example

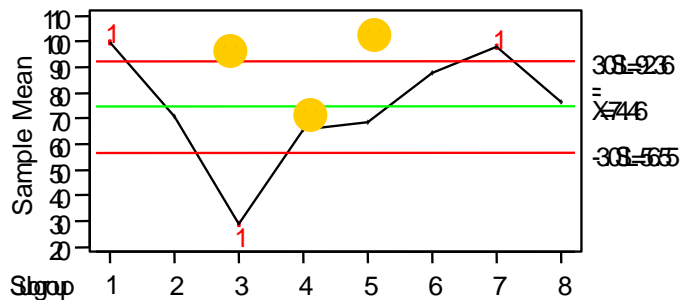
## Measurements

	Planning	Identify	Roots	Design	Implementation	Test	Formal	Customer	TOTAL	Leaked
Planning	2.03	0	0	0	0	0	0	0	2.03	0
Customer	1.8	1.4	0	4.06	0	16.15	0	23.41	21.61	
Roots	0	0	7.32	12.04	32.77	41.6	56.09	0.79	150.61	143.29
Design	0	0	0.13	41.99	8.2	23.2	118.94	5.28	197.74	155.75
Implementation	0	0	0.17	0.5	154	90.3	88.88	23.3	357.15	203.15
Test	0	0	0	0.16	0.03	19.93	4.5	0	24.61	4.69
Formal	0	0	0	0	0	2.34	149.25	0	151.59	2.34
Customer	0	0	0	0	0	0	2.7	13.6	16.3	13.6
TOTAL	2.03	1.8	9.02	54.69	199.06	177.36	436.51	142.97	923.44	544.43

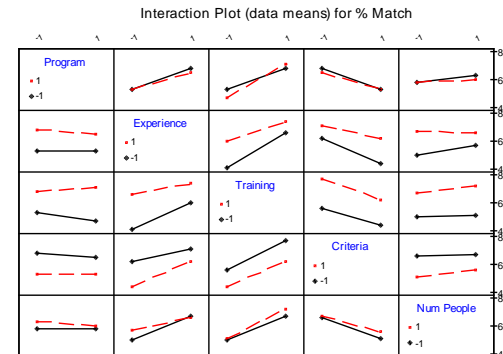
## Statistically understand



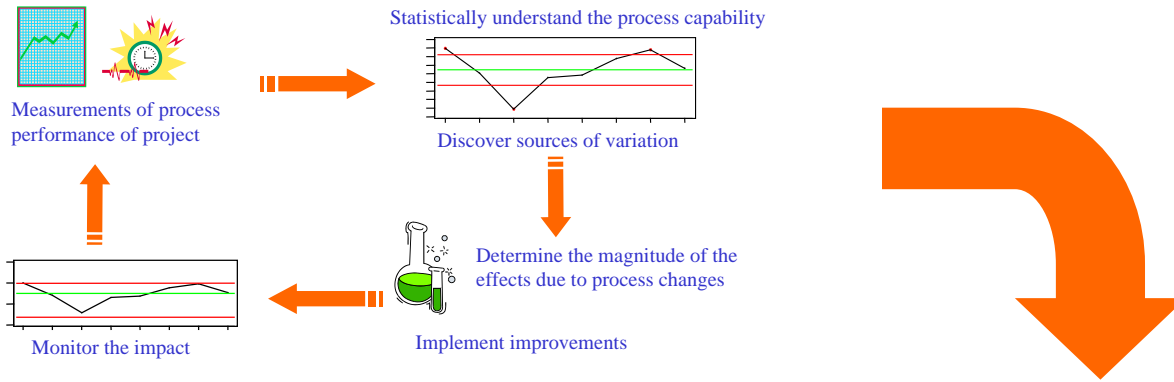
## Monitor the impact



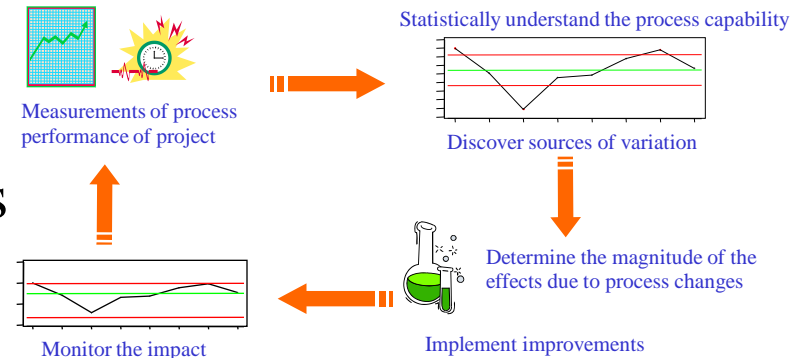
## Determine the magnitude



# Continuous Measurable Improvement



- Can be next biggest hitter
- Can be next quickest
- Can be next logical problem
- Can be anything the org. determines





# Questions



# That's All Folks

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