Six Sigma and Statistical Tools

November 2015

Agenda

- Lean Six Sigma
- What is Six Sigma?
- Understanding Six Sigma
- DMAIC Process
- Statistical Tools

Lean Six Sigma

Lean Six Sigma is a methodology which combines process **speed** with **quality**.

Lean focuses on speed and emphasizes reducing the amount of time between activities, events, and cycles. Lean eliminates waste found in a process.

Six Sigma is a methodology which focuses on reducing the number of errors in a process by identifying and reducing variation.

Ideally, Lean and Six Sigma are utilized together. After all, what good is it to complete a process quickly if the information is incorrectly entered?!

Lean Six Sigma – Two Types of Measures

Lean: Efficiency

Goal: Reduce waste and increase process speed

- Total Cost
- Time in Process
- Required FTEs
- Cost of Defects
- WIPs

Six Sigma: Effectiveness

Goal: Improve performance on Customer Critical Factors

- On-time Delivery
- Adherence to Requirements
- Accuracy
- Customer Satisfaction

What is Six Sigma?

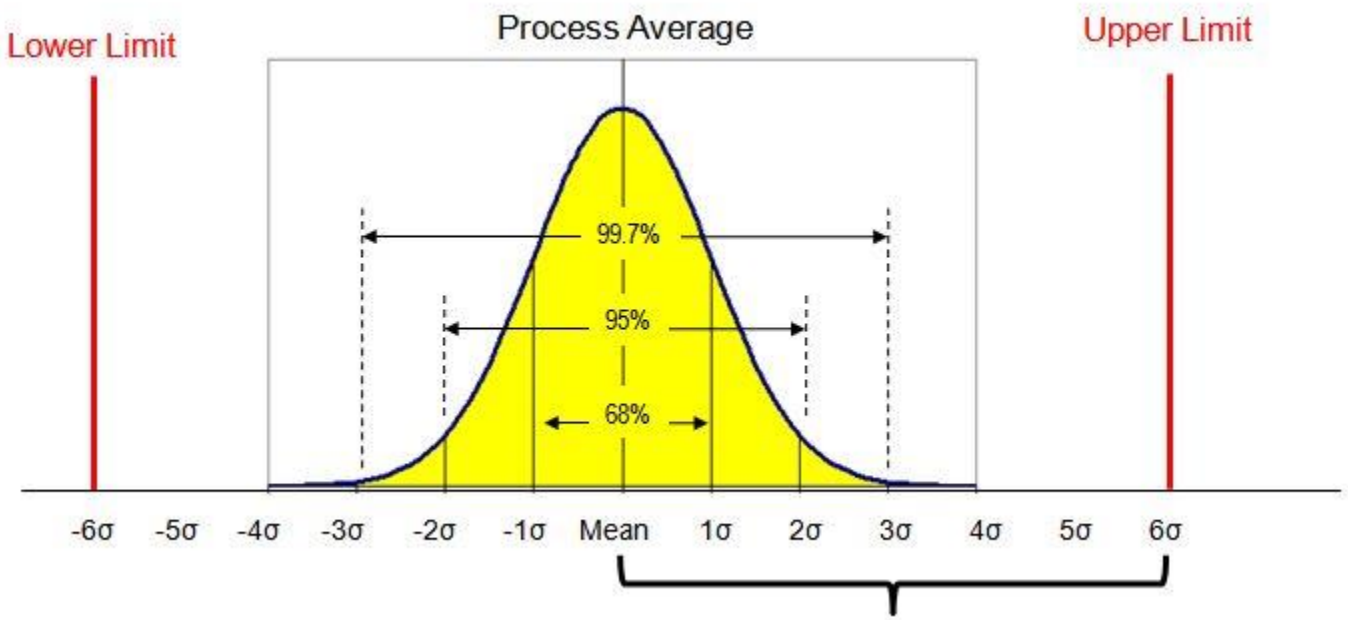
- It is a methodology for continuous improvement.
- It is a methodology for creating products/processes that perform at high standards
- It is a set of statistical and other quality tools
- It is a way of understanding where you are, where you want to be, and how to get there

Six Sigma

Four Ways to Look at Six Sigma

1. Statistical Meaning
2. Practical Meaning
3. Business Philosophy
4. Problem Solving Methodology

Six Sigma – Statistical Meaning



In a normal distribution, the interval created by the mean (average) plus or minus 3 standard deviations contains 99.73% of the data.

Six Sigma – Practical Meaning

99% GOOD (3.8 Sigma)

- 20,000 lost articles of mail per hour
- Unsafe drinking water for 15 min/day
- 5,000 incorrect surgical operations per week
- 2 short or long landings at most major airports each day
- 200,000 wrong drug prescriptions each year

99.99966% GOOD (6 Sigma)

- 7 lost articles of mail per hour
- 1 unsafe minute of drinking water every 7 months
- 1.7 incorrect surgical operations per week
- 1 short or long landing every 5 years
- 68 wrong drug prescriptions each year

Six Sigma – Practical Meaning

- 2,000,000 Paychecks Processed per Month

Sigma Level	Number of Errors
2 Sigma	616,740 Defective Paychecks per Month
3 Sigma	133,694
4 Sigma	12,436
5 Sigma	466
6 Sigma	7

Six Sigma – Business Philosophy

Six Sigma Begins and Ends with the Customer!!!

- Customer Focused
- Customer Defines Quality
- Variability is the Enemy – Get it right the first time
- Act on Fact – Make data driven decisions
- Measure – What you can't/don't measure, you don't know or understand
- Invest in Employees

Six Sigma – Problem Solving Methodology

DMAIC Methodology for Problem Solving

- **DEFINE**: Project purpose and scope
- **MEASURE**: Current performance
- **ANALYZE**: Root cause & propose solution set
- **IMPROVE**: By removing variation and non-value added activities
- **CONTROL**: The gains into the Future

Define

Purpose: Define business problem and opportunity; Lay the ground work for the project

Key Tools:

- Charter
  - Problem Statement
  - Goal - SMART
  - In Scope / Out of Scope
  - Team Members
- Project Plan – VSM, Kaizen, Implementation
- Value Stream Mapping
- Potential Project Impact

Measure

Purpose: Measure the problem, assess process performance

Key Tools:

- Data Collection
- Voice of Customer
- Fishbone Diagram
- FMEA
- Graphical Representation
- Revised Value Stream Map
- Just-Do-Its

Analyze

Purpose: Often intertwined with the Measure Phase, the purpose of the Analyze Phase is to understand the data

Key Tools:

- Data Analysis
- Value Add Analysis – Looking at the process through the customer's eyes
- Root Cause Analysis – Understand and verify the cause of the problem
- Value Stream Mapping (Future State)

Improve

Purpose: Develop Solutions to improve process capability and compare the results to the baseline performance. Often times the Improve phase includes a pilot.

Key Tools:

- Waste Elimination (5S)
- Poka-Yoke – Mistake Proofing
- Standardized Operating Procedures
- Training
- Documented Improvement or Action Plan

Control

Purpose: Roll out solution, execute control plan and transition to process owners. This ensures that any gains and improvements will be sustained after the Empire Belt has moved on to another project.

Key Tools:

- Training
- Improvement Plan
- Control Plan
- Celebrate Success!

Six Sigma Tools

1. FMEA
2. Bar Charts
3. Histograms
4. Pareto Charts
5. Variance and Control Charts

Failure Mode Effect Analysis

- Identify the ways in which a product or process could potentially fail
- Estimate the risk associated with causes
- Prioritize the actions to reduce the risk
- Evaluate the current control plan
- Improve the process in a preemptive manner
- Prioritize Resources to ensure process improvement efforts are beneficial

When to Use FEMA

- Define/Measure – To develop ways in which a process could fail
- Analyze – To determine root cause and develop potential solutions
- Improve/Control – Evaluate improvement plan

FMEA Steps

1. Identify Process Element – What process step is creating the most defects?
2. Identify Failure Mode – Manner in which a desired result is not achieved
3. Identify the Failure Effect – What is the effect on the process?
4. Identify Failure Cause – What brought about failure mode?
5. Identify Control Factors – What can be put in place to prevent the failure?

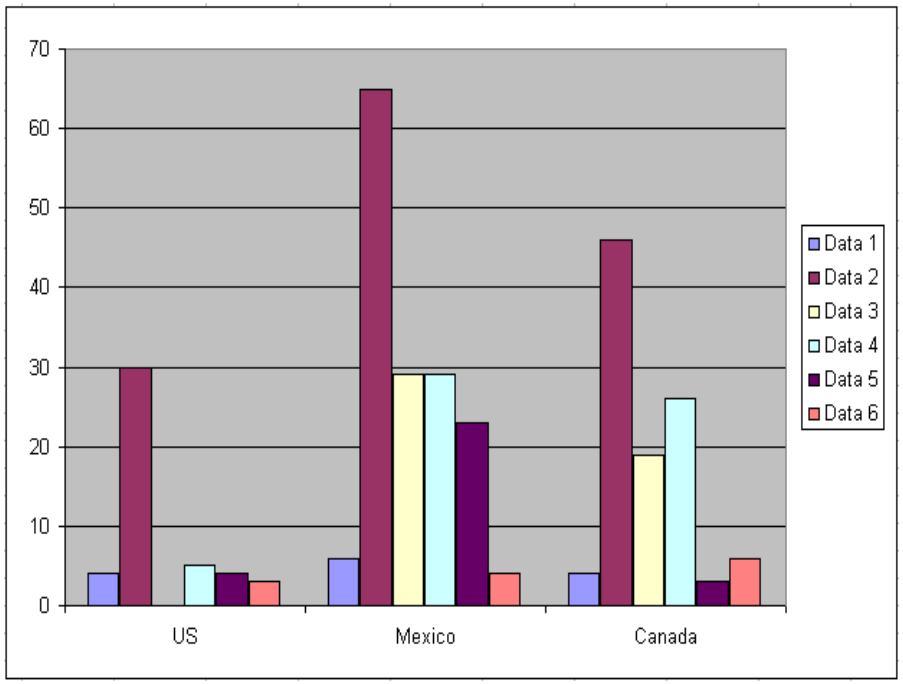
Bar Charts

Purpose: Used for direct comparison of magnitude for descriptively labeled categories.

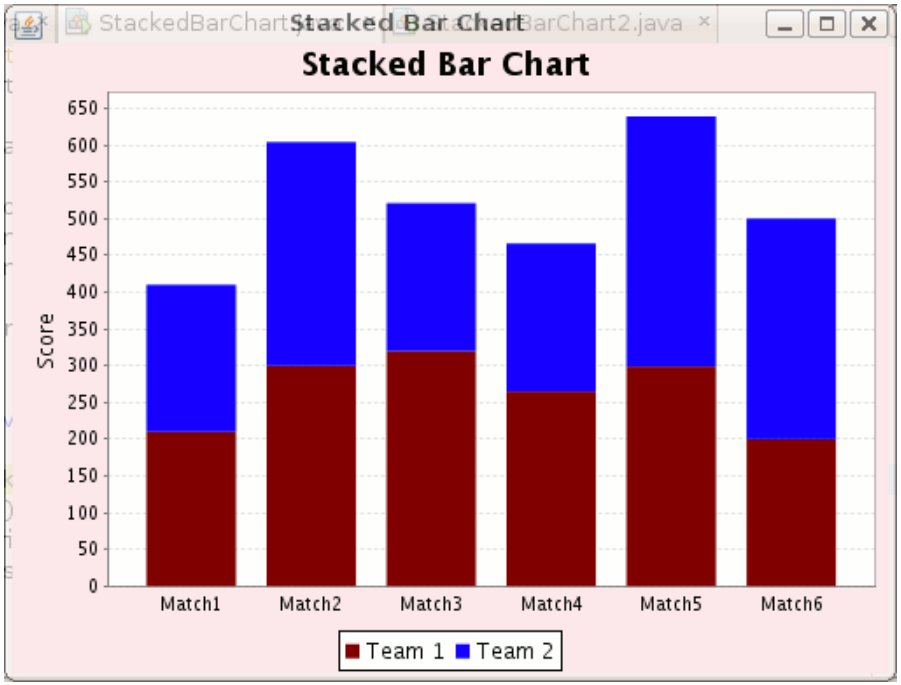
How to Make: Separate data into groups (e.g. stratifications from your data collection plan. Plot groups on the horizontal axis and counts on the vertical axis.

Questions Answered: How do various groups compare to one another

Bar Charts



Clustered Bar or Clustered Column



Stacked Bar Chart – Shows the relationship of individual items to the whole.

Histograms

Purpose: Used to display the distribution of a data set.

How to Make:

Divide the data into equally sized groups.

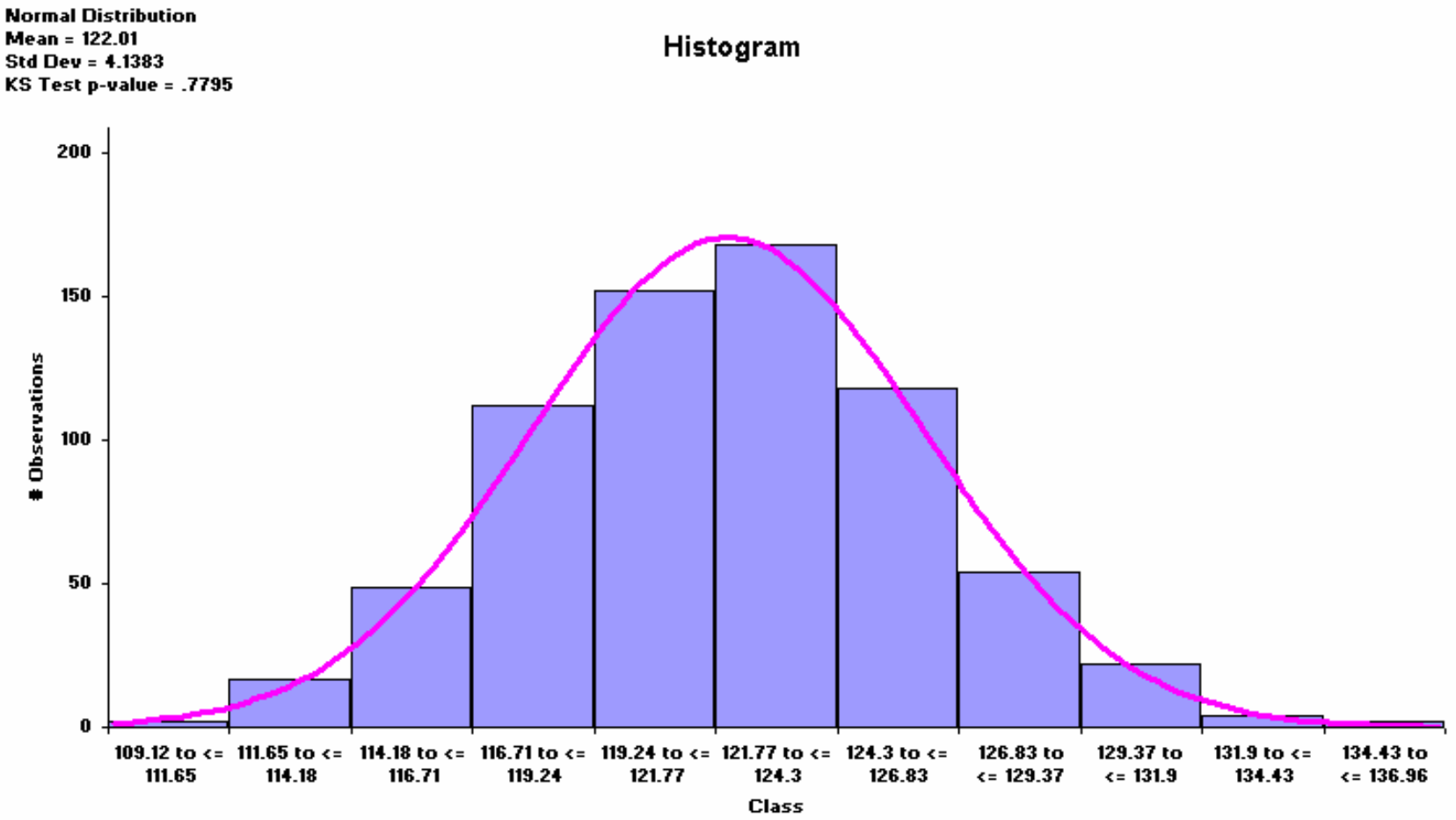
Group Size = (highest – lowest) / number of groups

Plot frequency on vertical axis.

Questions Answered:

- What is the most common system response?
- What distribution does the data have?
- Is the data symmetric or skewed?
- Does the data contain outliers?

Histograms


Normal Distribution
Mean = 122.01
Std Dev = 4.1383
KS Test p-value = .7795
Histogram
Observations
200
150
100
50
0
109.12 to <= 111.65
111.65 to <= 114.18
114.18 to <= 116.71
116.71 to <= 119.24
119.24 to <= 121.77
121.77 to <= 124.3
124.3 to <= 126.83
126.83 to <= 129.37
129.37 to <= 131.9
131.9 to <= 134.43
134.43 to <= 136.96
Class

Pareto Chart

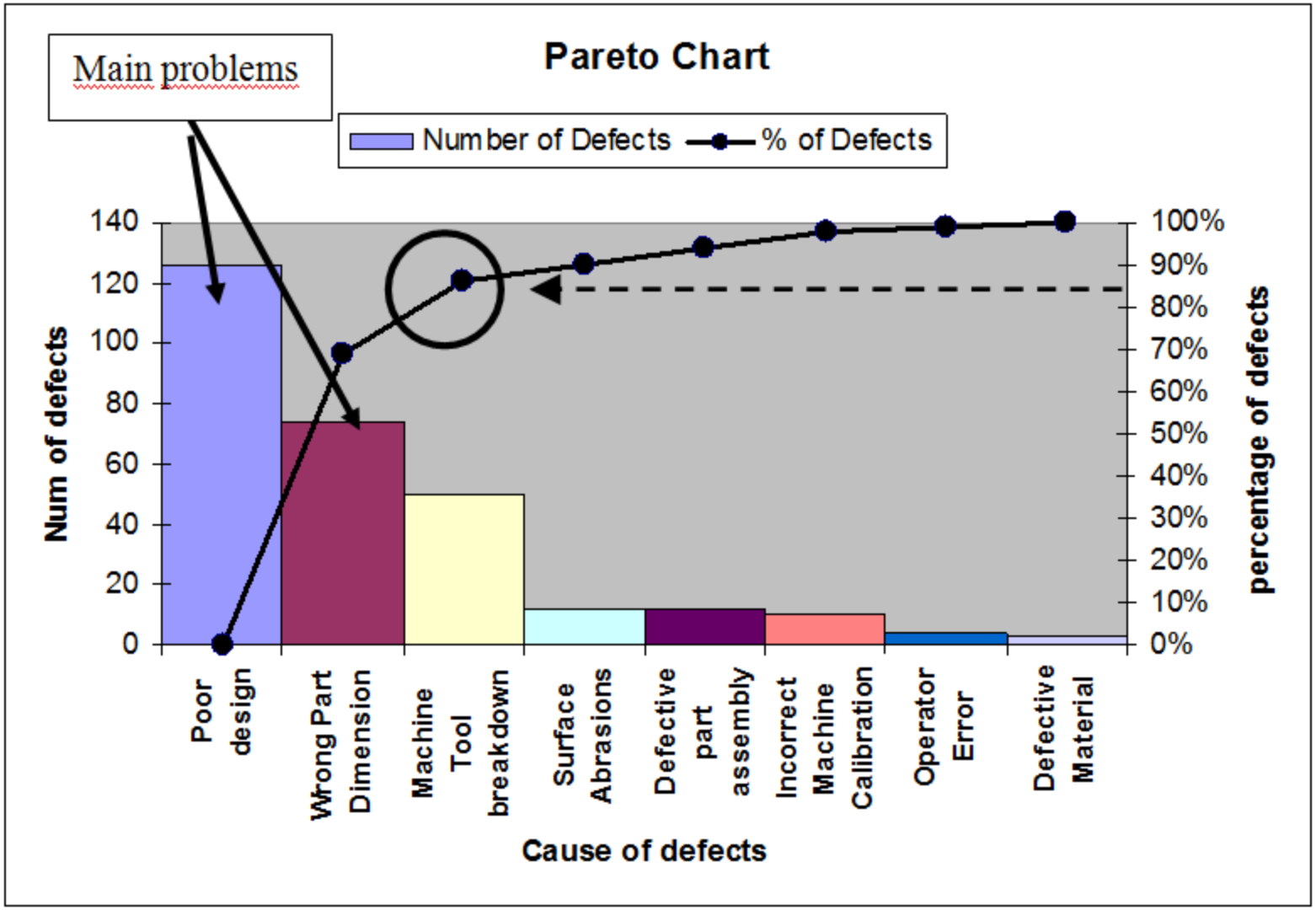
Purpose: Used to focus efforts on problems that have the greatest potential for improvement.

How to Make: Order the categories from highest to lowest (represented by bars). A line graph is used to represent the cumulative total.

Questions Answered:

- What are the largest issues facing our team or business?
- What 20% of sources are responsible for 80% of the problem (80/20 Rule)?
- Where should we focus our efforts to achieve the greatest improvements?

Pareto Chart

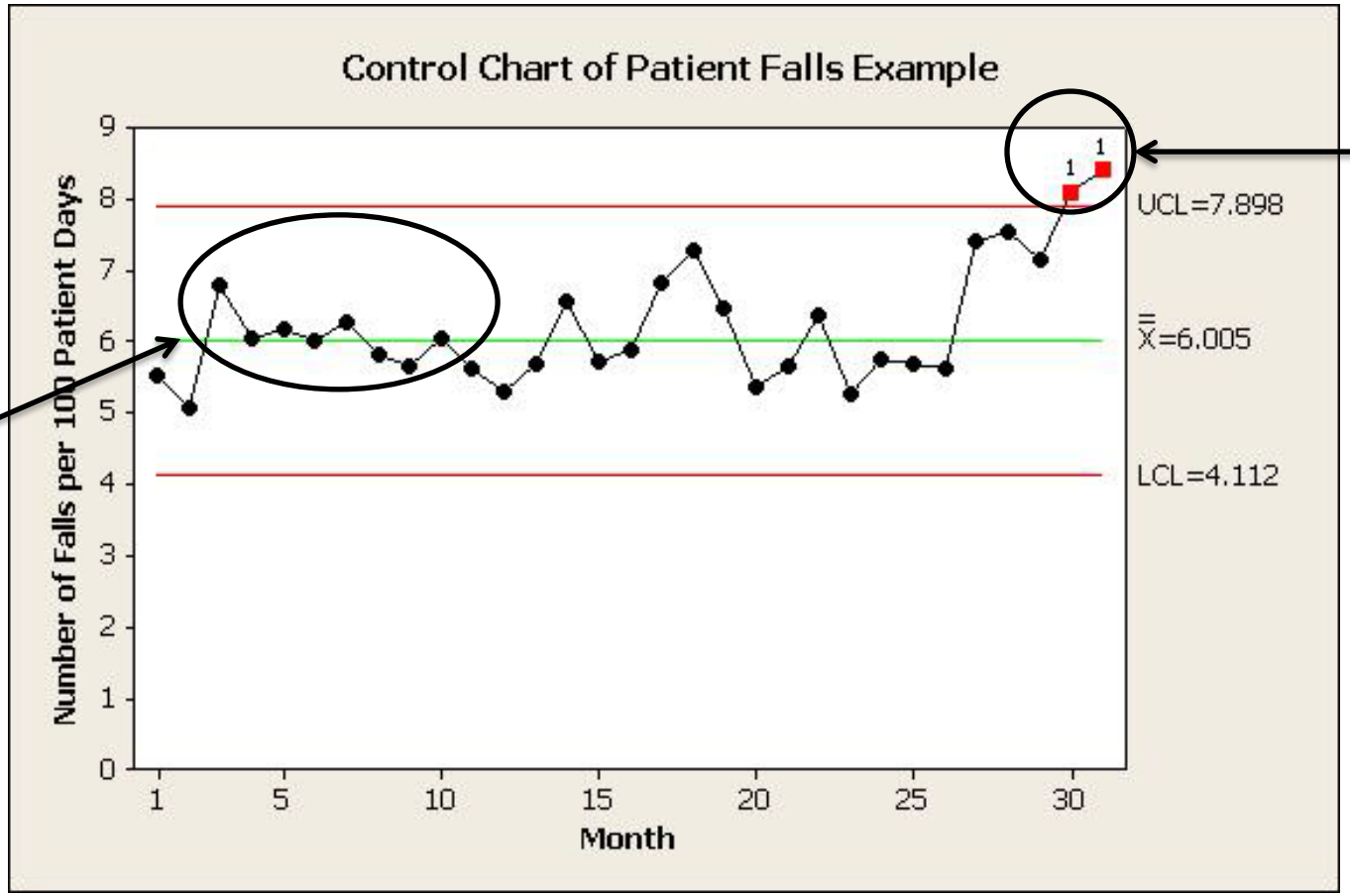


Types of Process Variation

- **Common Cause Variation** – The sum of many chance causes. Common Cause Variation is not traceable to a single major cause. It is essentially the "noise" in the system. When a process is operating with Common Cause Variation, it is in a state of statistical control.
- **Special Cause Variation** - Variation resulting because of a difference between people. Machines, materials, methods, etc. The occurrence of special or assignable cause results in an out of control condition.

Control Charts provide a way to distinguish between Common Cause Variability and Special Cause Variability.

Control Chart



Common Cause Variation

Special Cause Variation

Questions?