

# LEAN Ohio

**Transforming the Public Sector**

**Green Belt**

**Basic Control Charts**

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# Basic Control Charts

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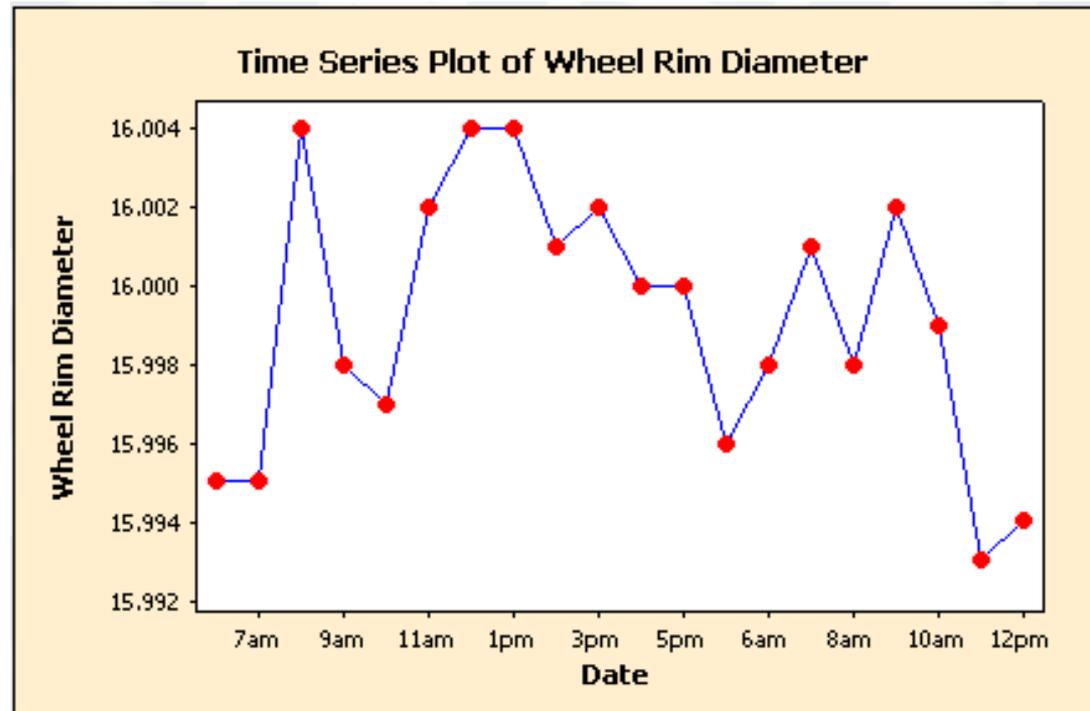
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# Objectives

- Discuss different types of variation
- Review run charts and control charts
- Introduce basic control charting methods
- Discuss the interpretation of control charts

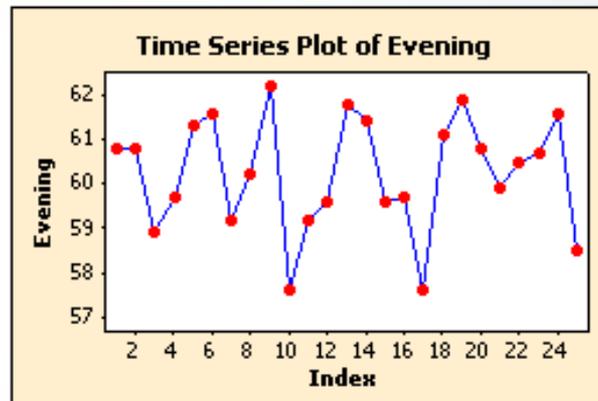
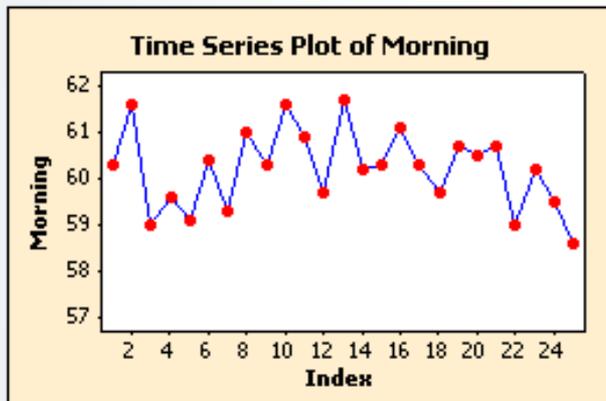
# Run Charts

- Time Series Plot or Run Charts displays numeric data in time order. We will refer to them as **Run Charts**
- Used to show patterns over time.



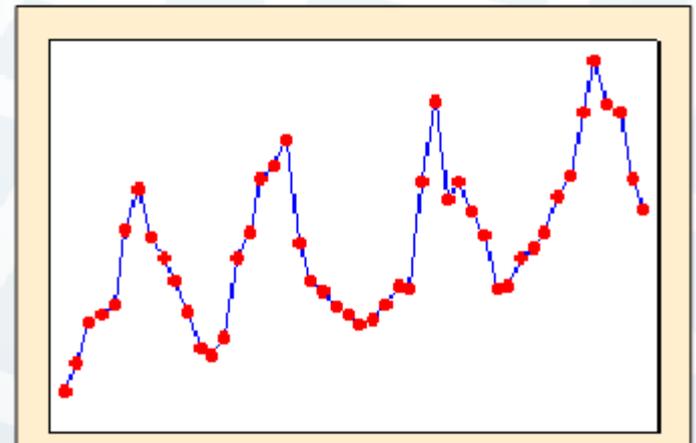
# Run Charts

- Help us spot time dependent patterns
  - Changes in the mean or variability over time



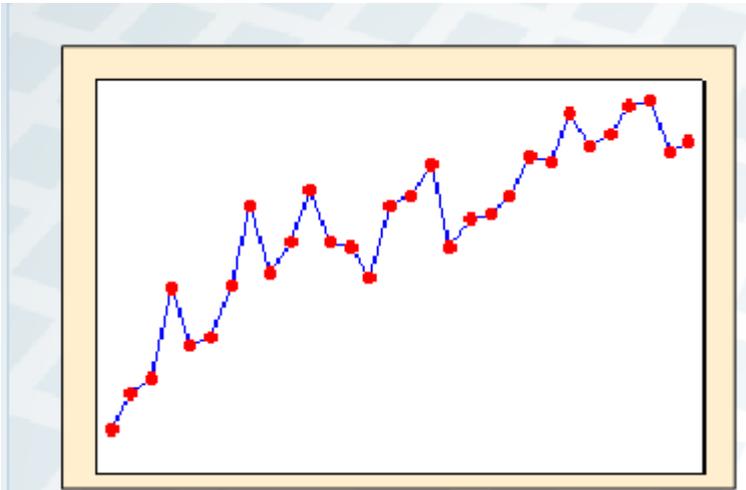
Variability Over Time

Seasonal Fluctuations

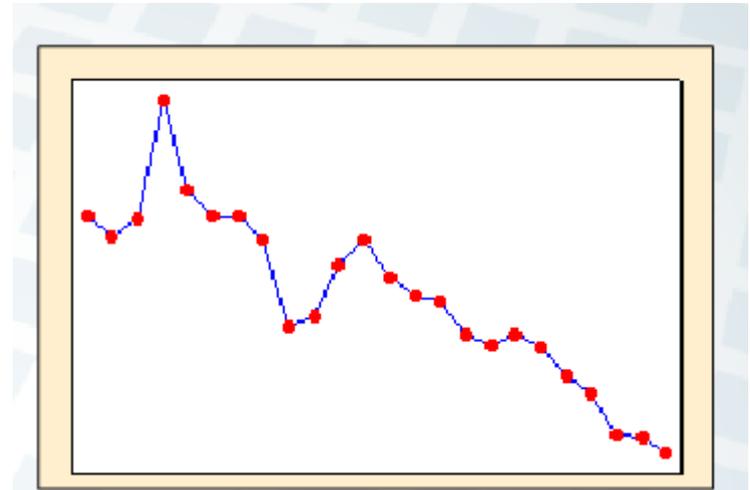


# Run Charts: Trends

- Help us spot time dependent patterns or trends
  - Increasing and decreasing trends



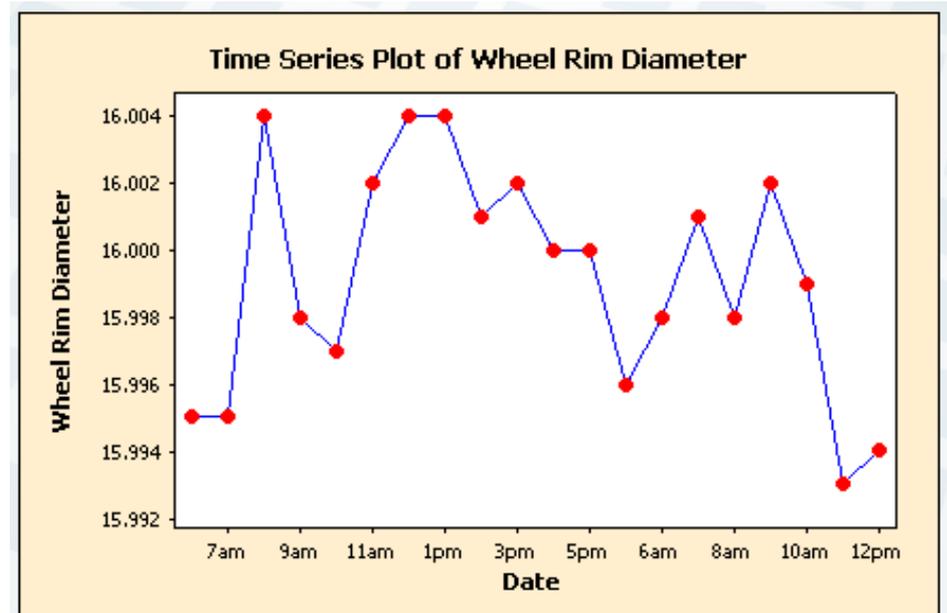
Positive



Negative

# Run Charts – Control Chart

- We use time series plots to discover time-related patterns in data
- This plot suggest that there is some variation in the process. Is this variation natural to the process or is something unusual going on?



# Control Charts

- We answer this question by expanding on the run chart to create a **control chart**
- A control chart helps us determine if a process is in statistical control/stable
- To determine true statistical control, control charts should only be used with a normal data sets

# Basic Control Charts Overview

## *What is the tool?*

- A Control Chart can be considered a road map of...
  - ... where you have been.
  - ... where you are
  - ... where you may be headed
- Because of the statistics, control charts can recognize good and bad changes

## *Why do you use the tool?*

- By using control charts, you can detect change in a process. In other words, “Something is statistically different in my process.” To obtain a basic understanding of when a process is “out of statistical control.”
- To visually see how your process varies within the control limits.

# Common Cause vs. Special Cause Variation

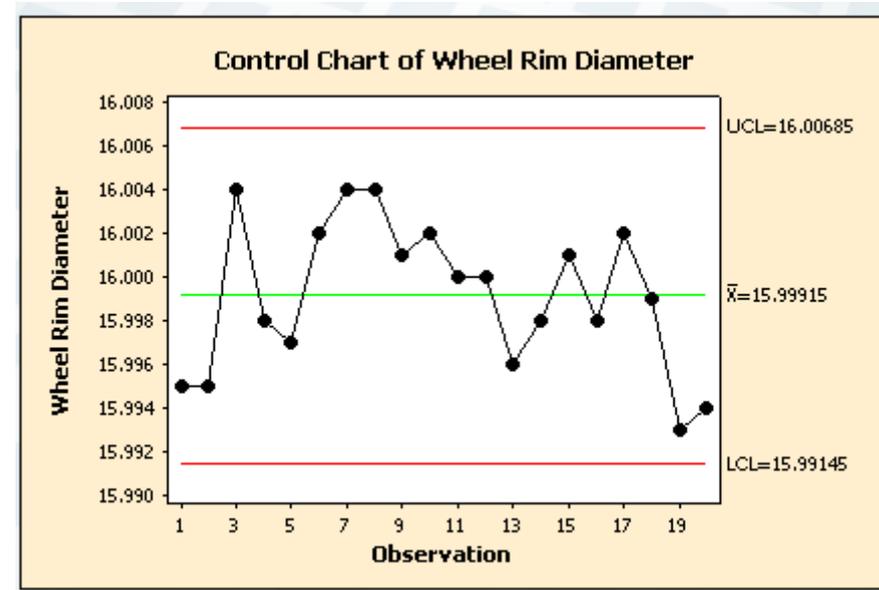
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# Control Charts: Stable Process

- A stable process is one in which the sources of variation are consistent over time
- Processes can vary due to many different factors
- Variables that occur naturally in the process are: **common-cause variation**

Stable Process



# Types of Variation - Common vs. Special

- Common Cause (Noise)\*
  - Is present in every process
  - Is produced by the process itself (the way we do business)
  - Can be lessened but requires a fundamental change in the process

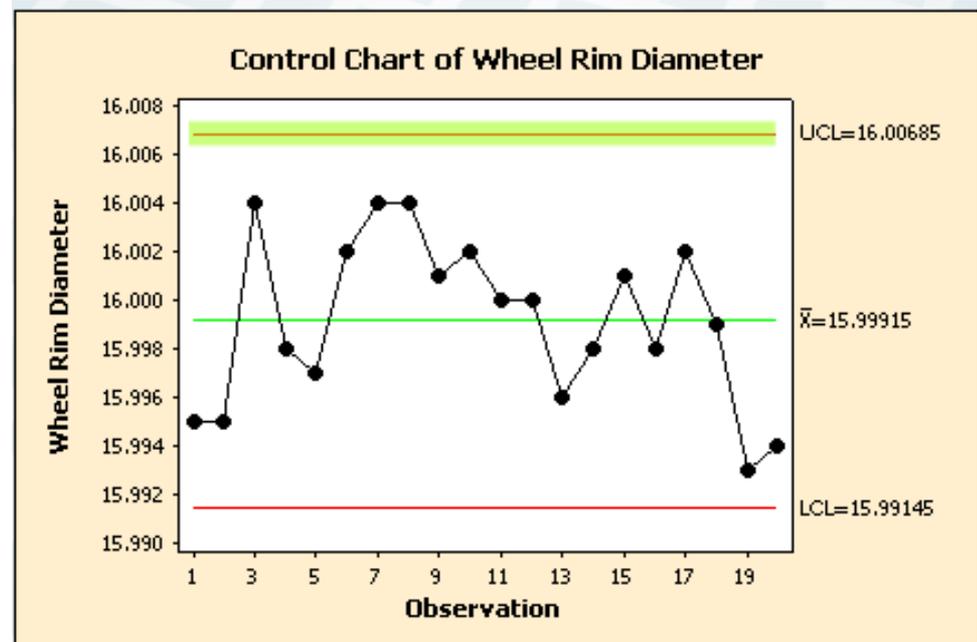
A process is **Stable, Predictable, and In-Control** when only Common Cause Variation exists in the process

# Control Limits

- Control limits represent the normal amount of variation we would expect to see if the process is consistent over time
- These are calculated using the data set and are referred to as sigma limits
- Sigma limits indicate when there are unusual sources of variation affecting a process

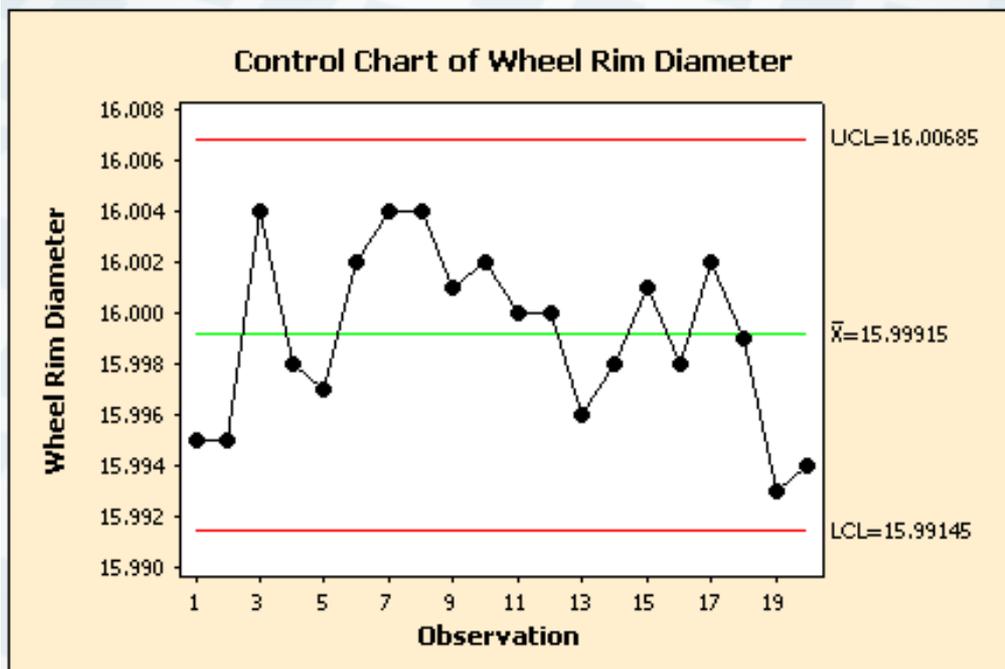
# Control Limits

- Typically, the upper control limit (UCL) is 3 sigma limits about the center line
- The lower control limit (LCL) is 3 sigma limits below the center line



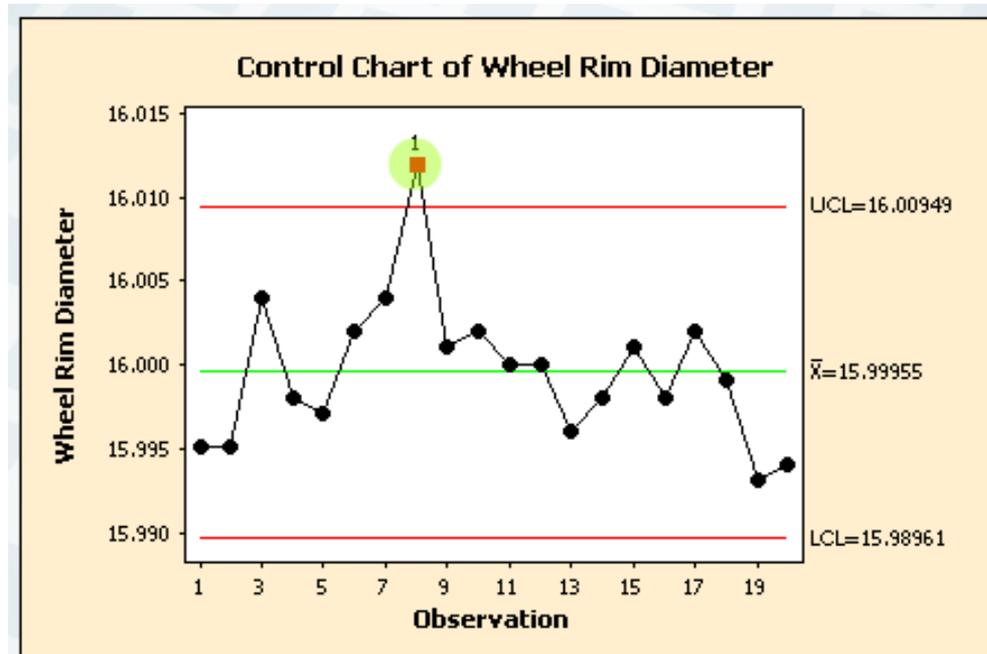
# In Control

- A process is **in control** when points are within the control limits with no obvious pattern



# Special-Cause Variation

- An **out-of-control** process is affected by something unusual: **special-cause variation**.



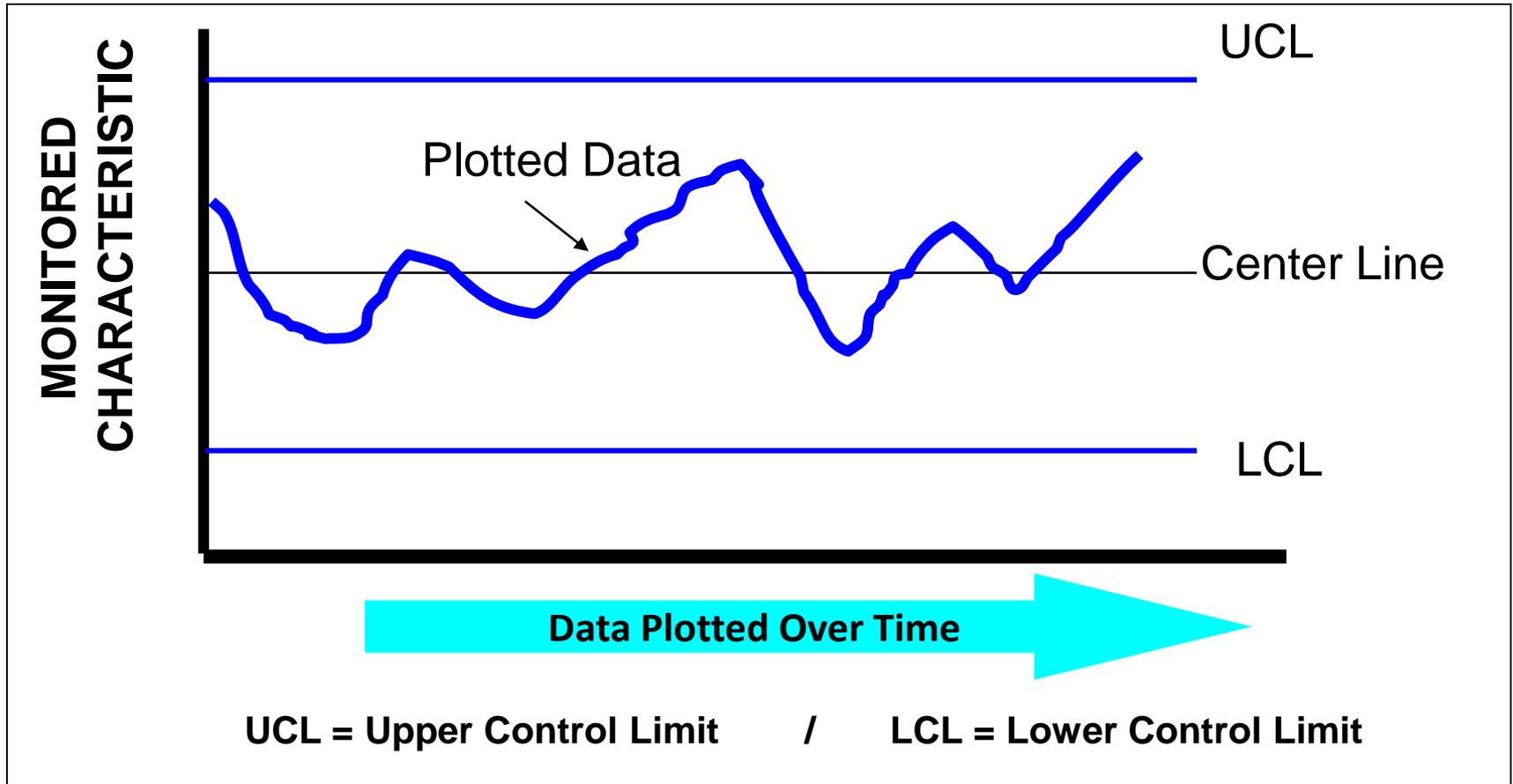
**Out of Control Process**

# Types of Variation – Common vs. Special

- Special Cause (Signals)\*
  - Unpredictable
  - Typically large in comparison to common cause variation
  - Caused by unique disturbances or a series of them
  - Can be removed/lessened by basic process control and monitoring

A process exhibiting Special Cause variation is said to be **Out-of-Control** and **Unstable**

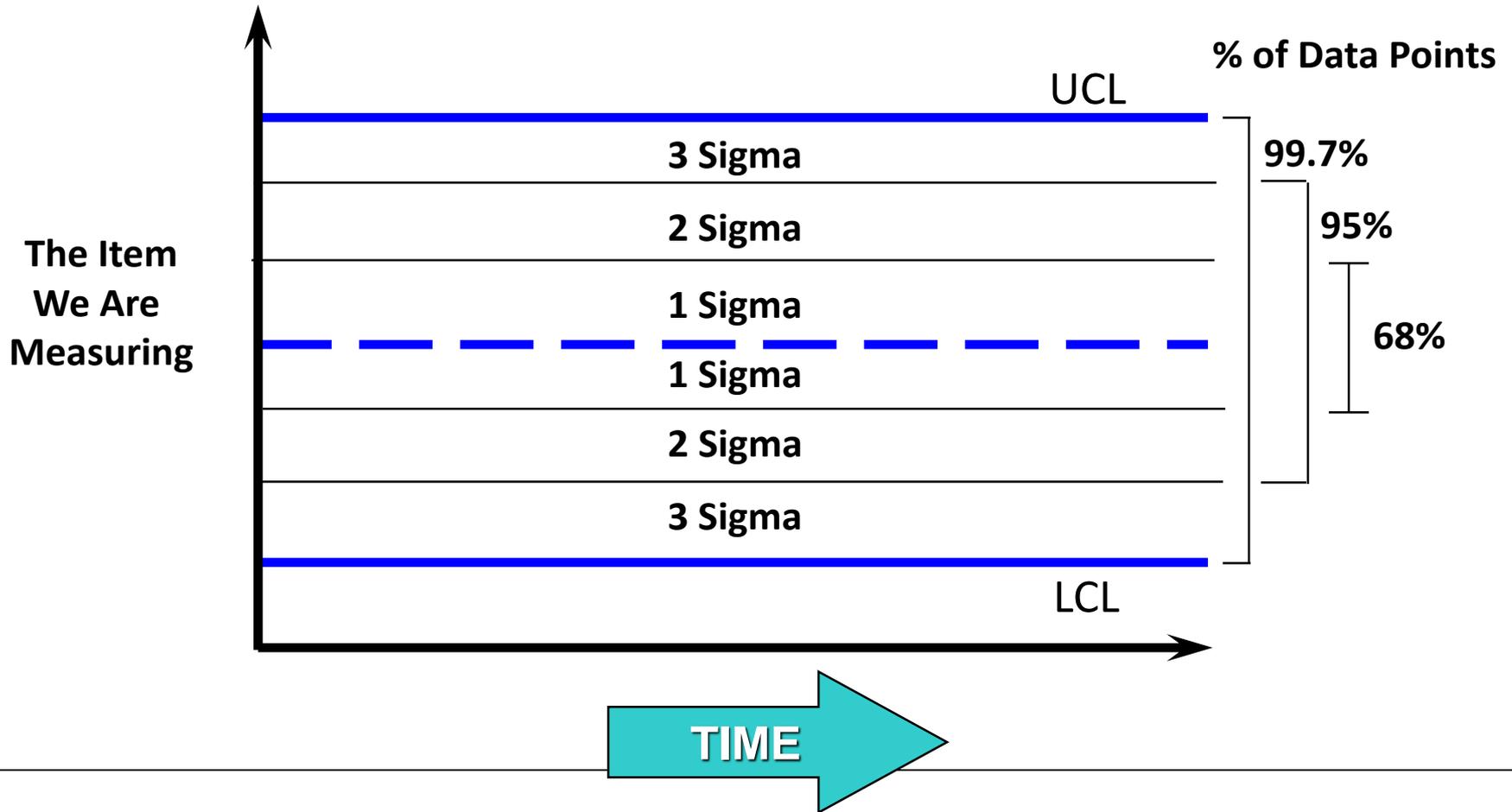
# The Basic Control Chart - Key Elements



**Over Time** means in chronological order

# Rules of Standard Deviation

“Where does the data lie?”



# Control Chart Rules

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# Control Chart Rules

## The Rules We Will Most Often Use:

**Rule 1:** One point more than 3 sigmas from center line

**Rule 2:** Nine points in a row on the same side of center line

**Rule 3:** Two out of three points more than 2 sigmas from center line (same side)

**Rule 4:** Four out of five points more than 1 sigma from center line (same side)

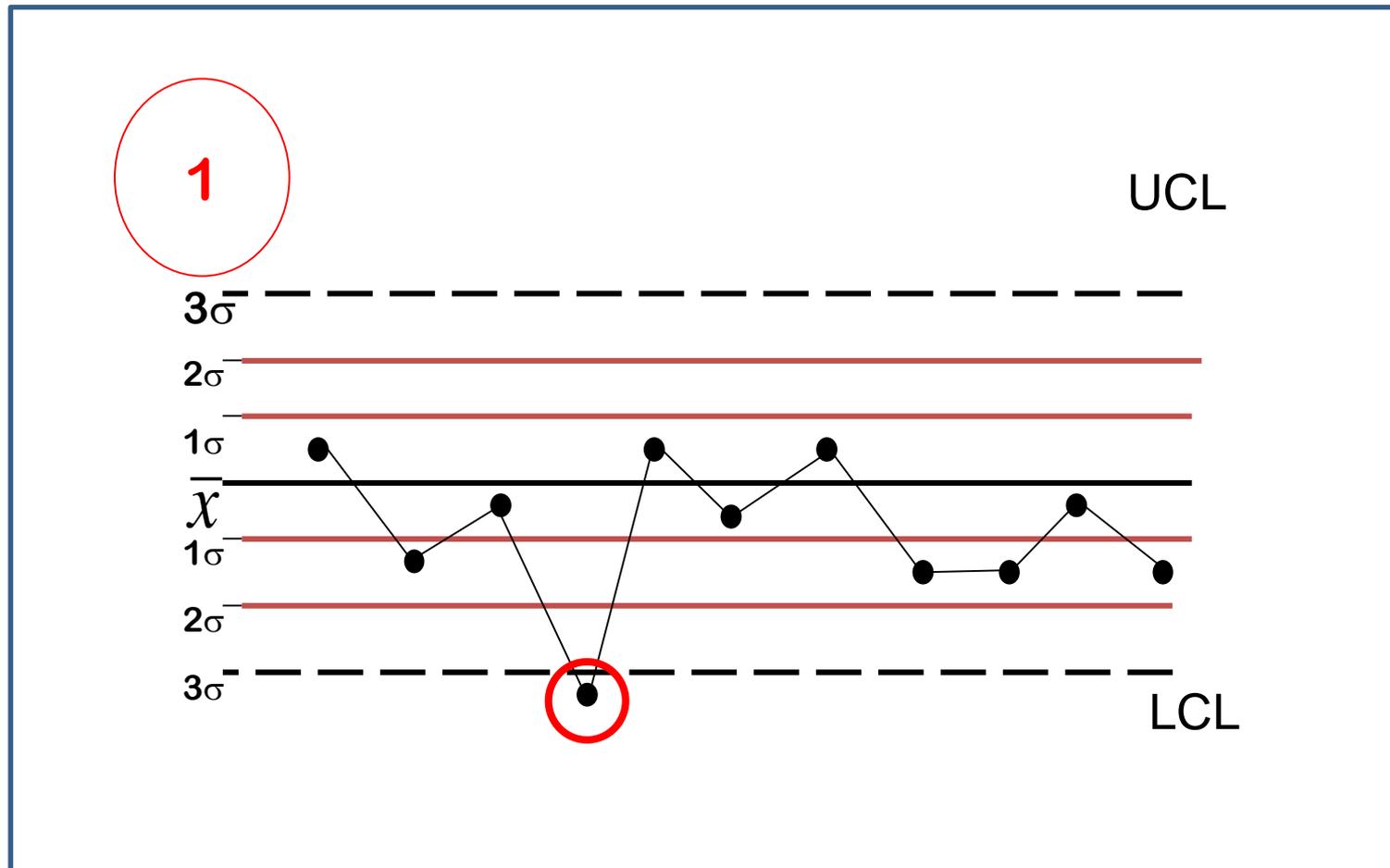
**Pattern Rule:** A pattern repeats itself

**Rule of Seven:** seventh or more consecutive data points fall on one side of the mean

When one of these rules is broken, we say that the process is  
**“out of *statistical* control”**

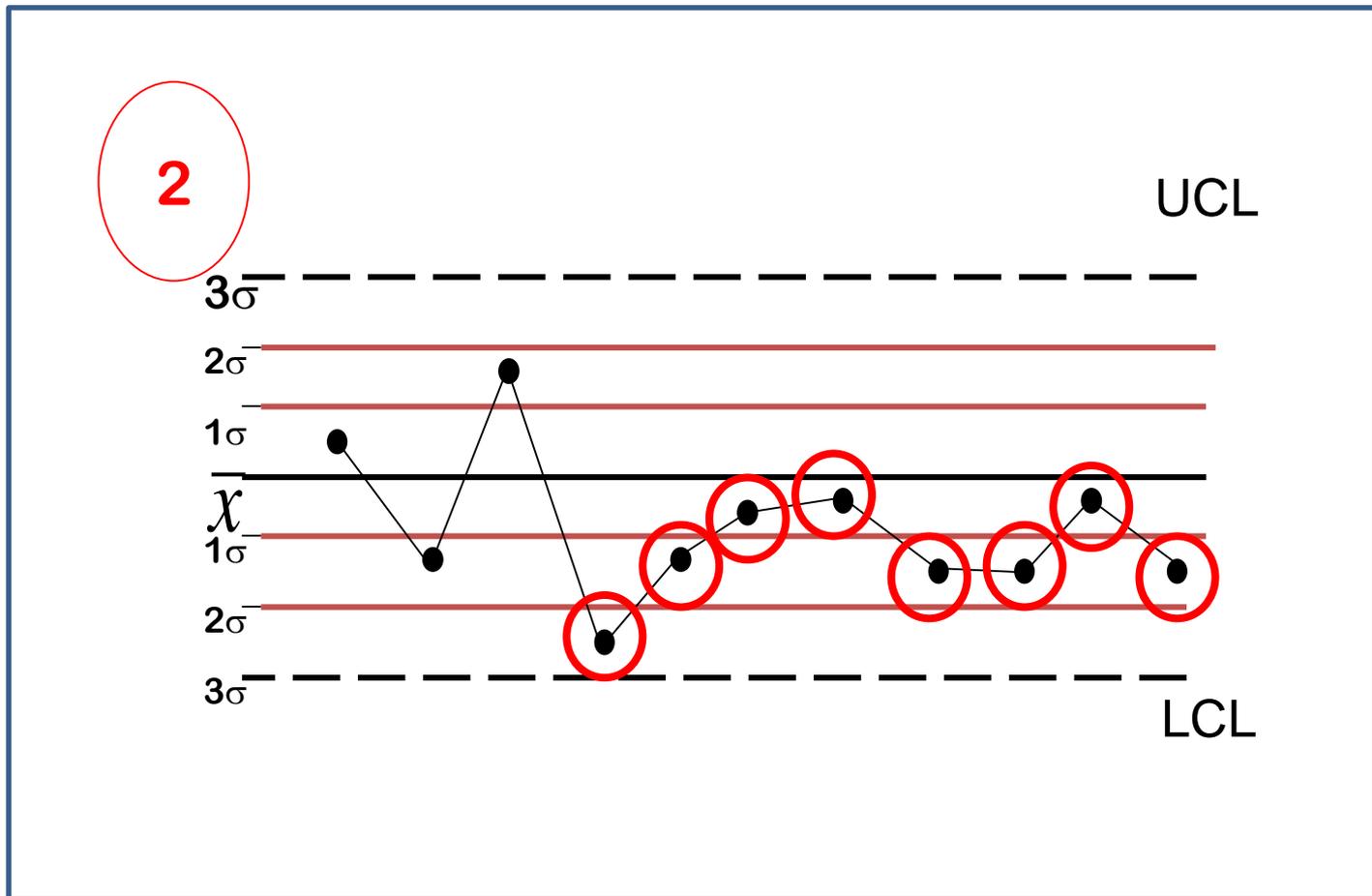
# Rule 1 of Detection

One point more than 3 sigmas from the center line



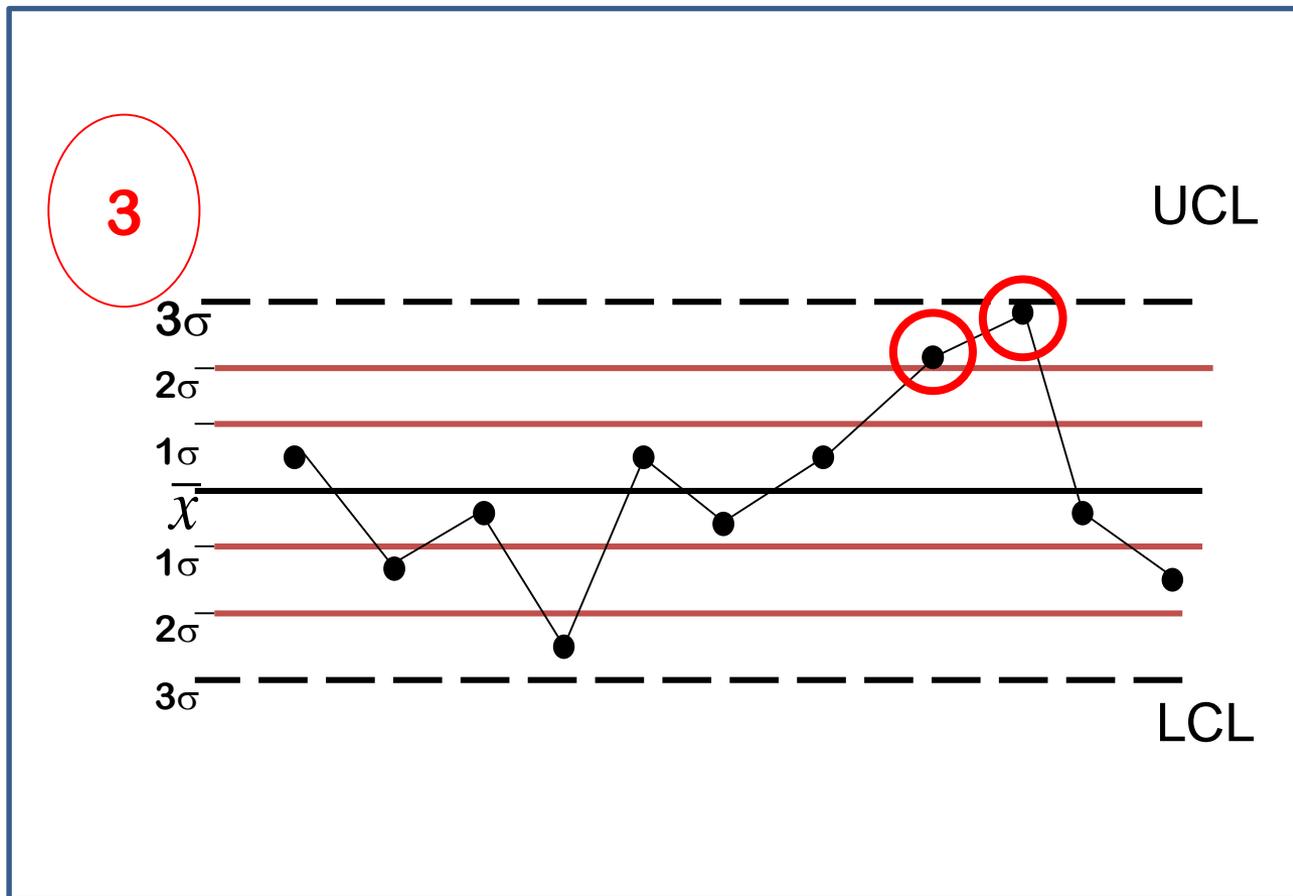
# Rule 2 of Detection

Nine points in a row on the same side of the center line



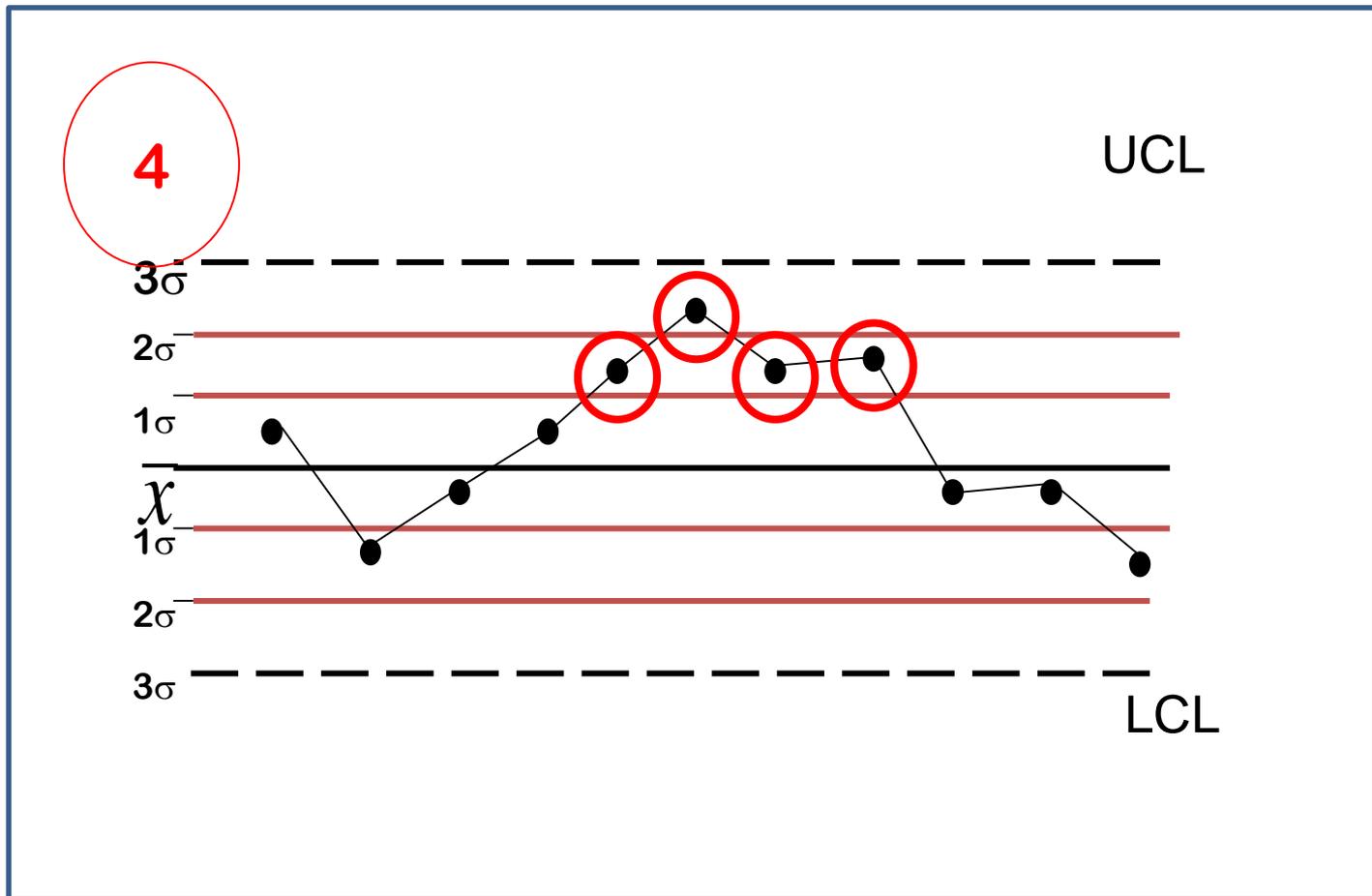
# Rule 3 of Detection

Two out of three points more than 2 sigmas from the center line (same side)



# Rule 4 of Detection

Four out of five points more than 1 sigma from the center line (same side)



# Detecting Lack of Control

- What do you do when you determine that the process is out of control?
- Go do some Investigating:
  - Could be anything from data entry errors to good things occurring

# Basic Control Charts - Limitations

Control charts will not pinpoint what or why something has changed

# Control Charts vs. Specification Limits

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# Control Limits vs. Spec Limits

- Process control limits are calculated based on data from the process
- Specification limits come from the customer
- Product specification limits are not found on the control chart
- Understanding how the process matches up against customer requirements is important to know

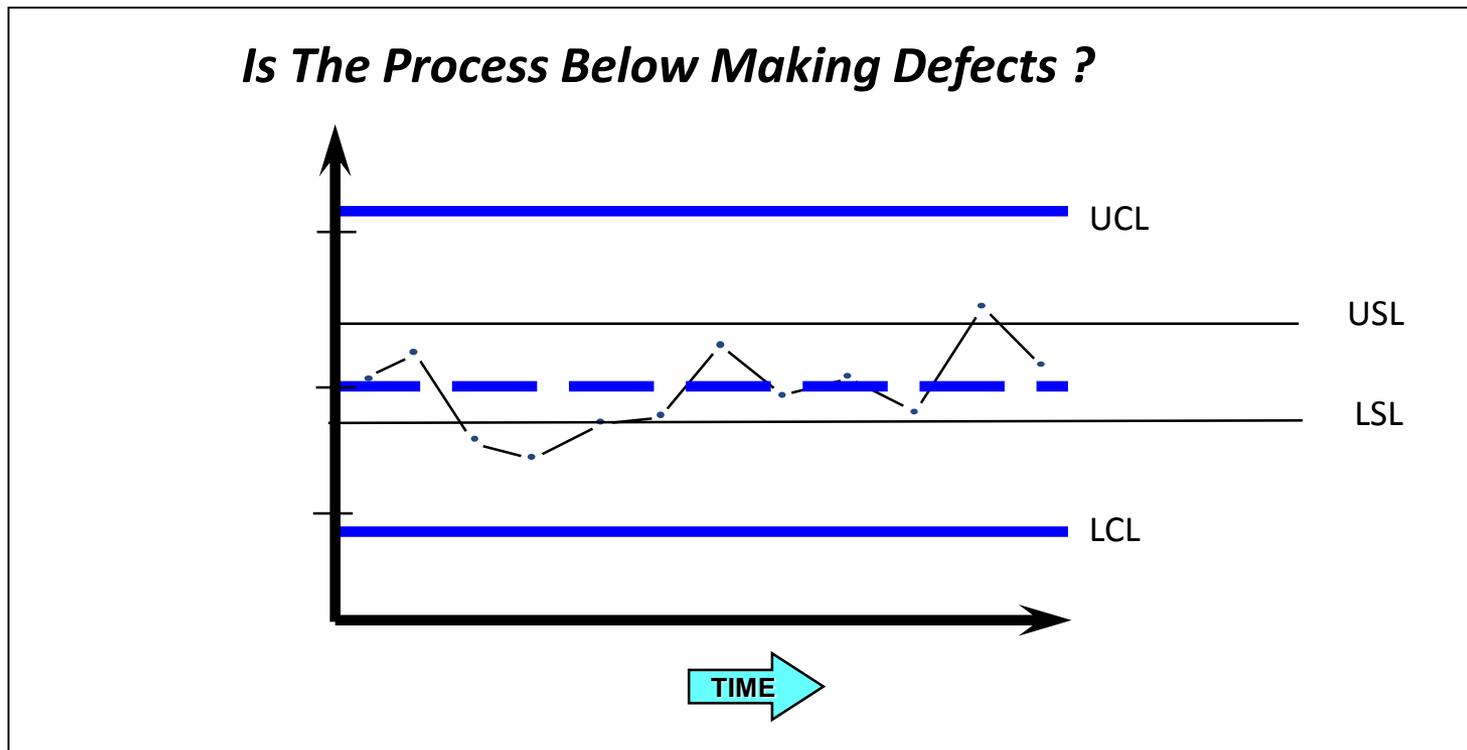
# Control Limits vs. Spec Limits

Upper Control Limits = UCL

Lower Control Limits = LCL

Upper Specification Limits = USL

Lower Specification Limits = LSL



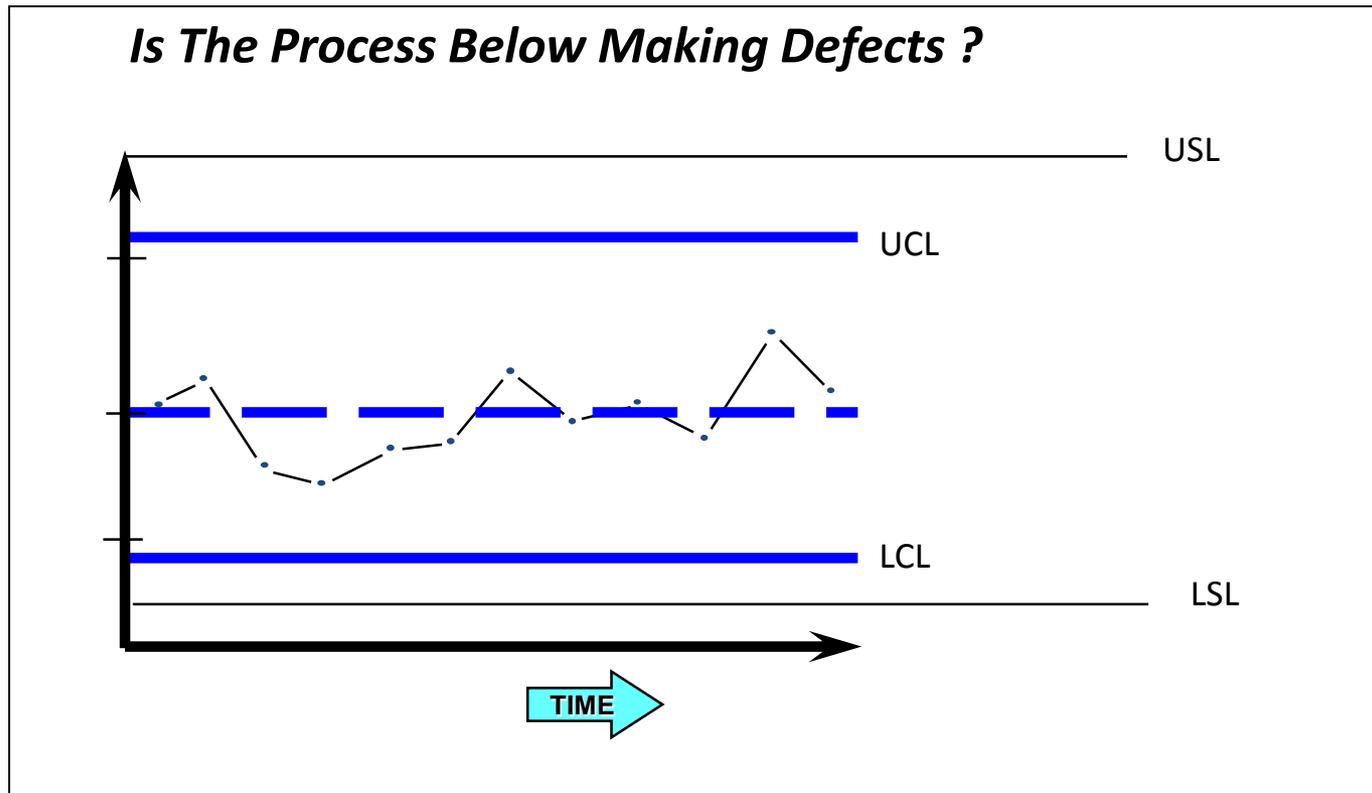
# Control Limits vs. Spec Limits

Upper Control Limits = UCL

Lower Control Limits = LCL

Upper Specification Limits = USL

Lower Specification Limits = LSL



# Three Big Control Chart Errors

- 1) Putting specification limits on a Control Chart
- 2) Treating UCL and LCL as specification limits
- 3) Not putting data in chronological order

When you do any of these the control chart becomes just an inspection tool - it's no longer a control chart

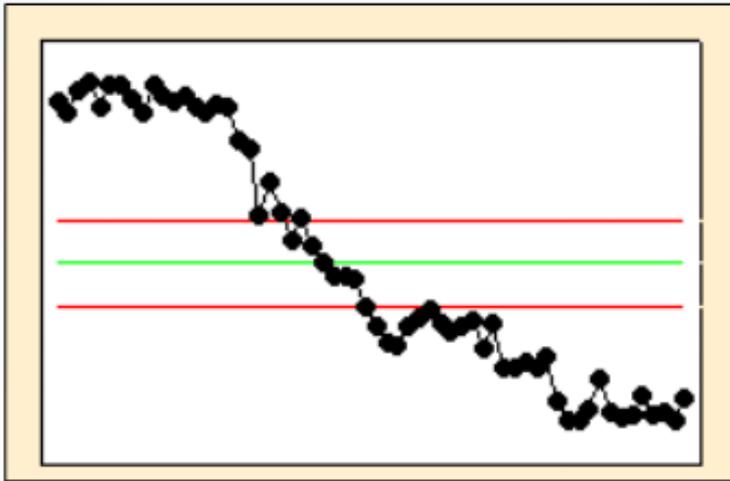
# Basic Control Chart Fundamentals

- Control charts require maintenance and should be used sparingly
- At least 10 data points (samples of parts) must be gathered prior to building these control charts
- Appropriate action must be taken when signaled by the control chart

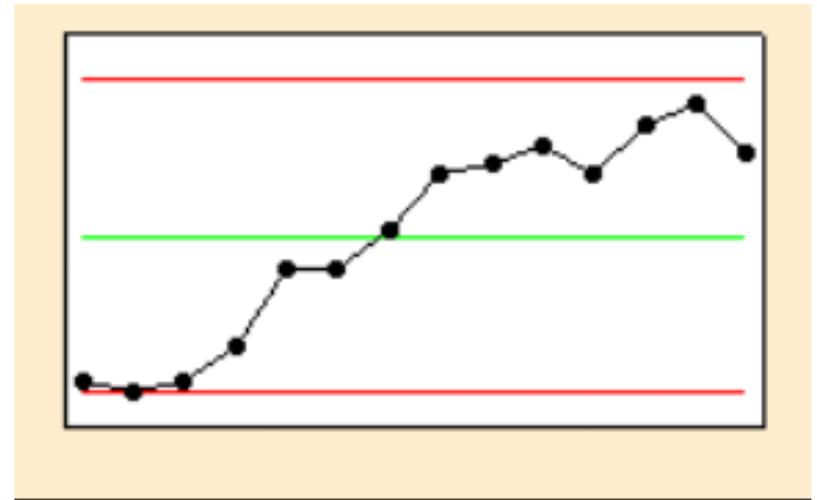
# Reading Control Charts

Control Charts can tell us about the process.

- Decreasing or Increasing over time:



Decreasing

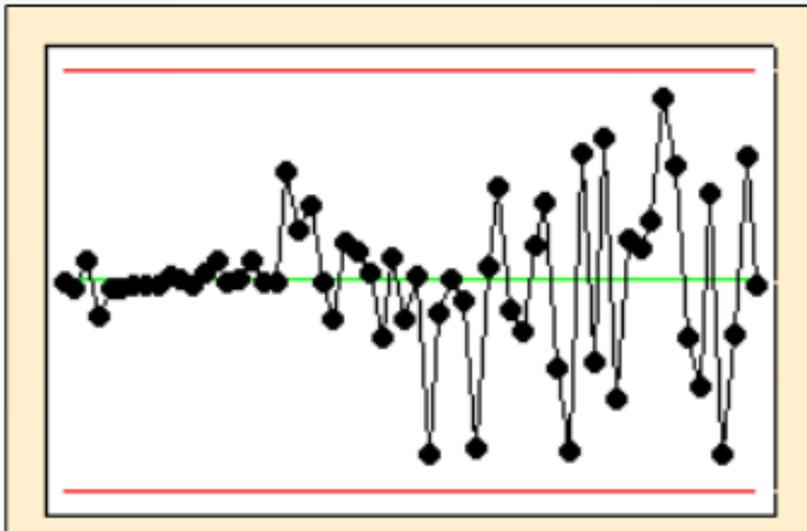


Increasing

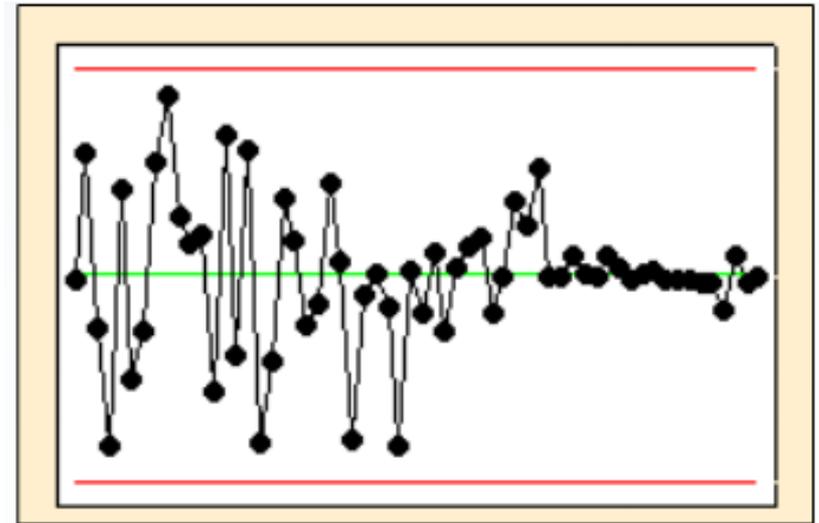
Which is Out Of Control?

# Control Charts Variation

Control Charts also show when **variation** is increasing or decreasing over time.



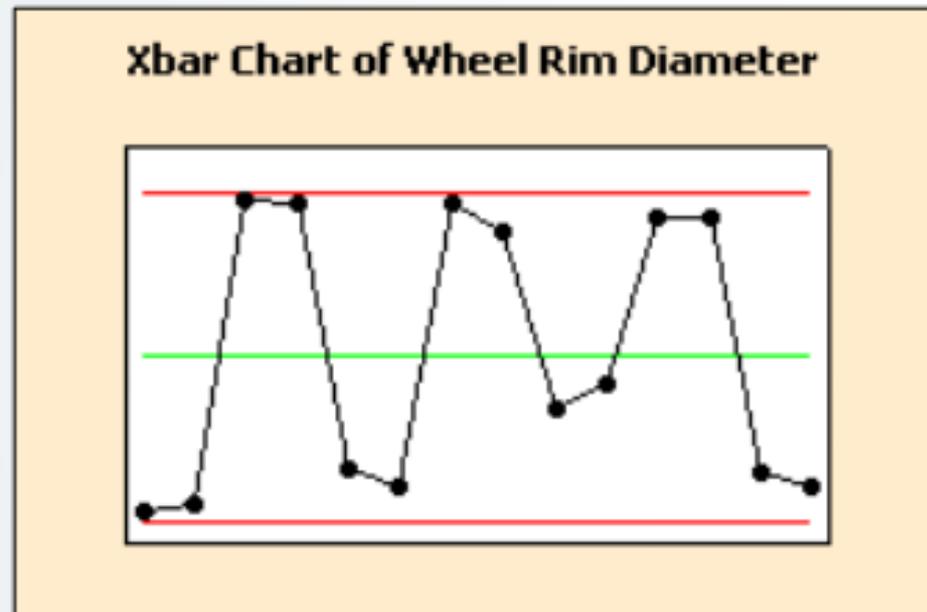
Variation Increasing



Variation Decreasing

# Control Charts Variation

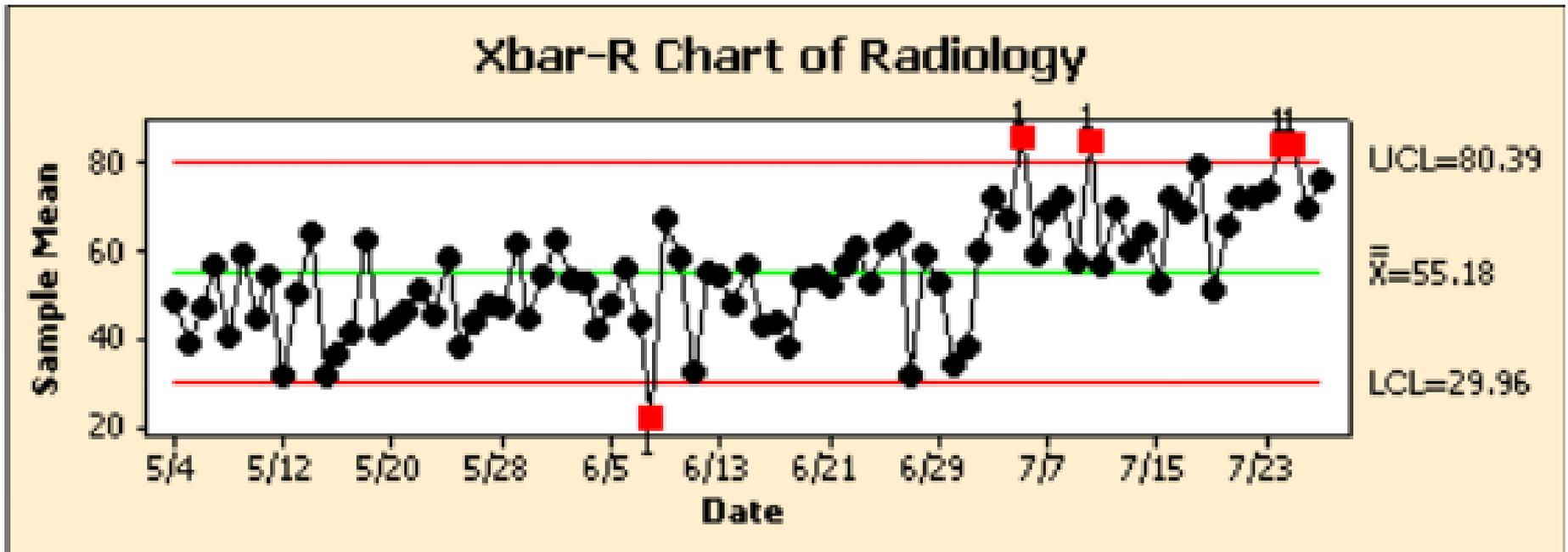
- Can show us patterns: When you see patterns in the data – your process is Out of Control



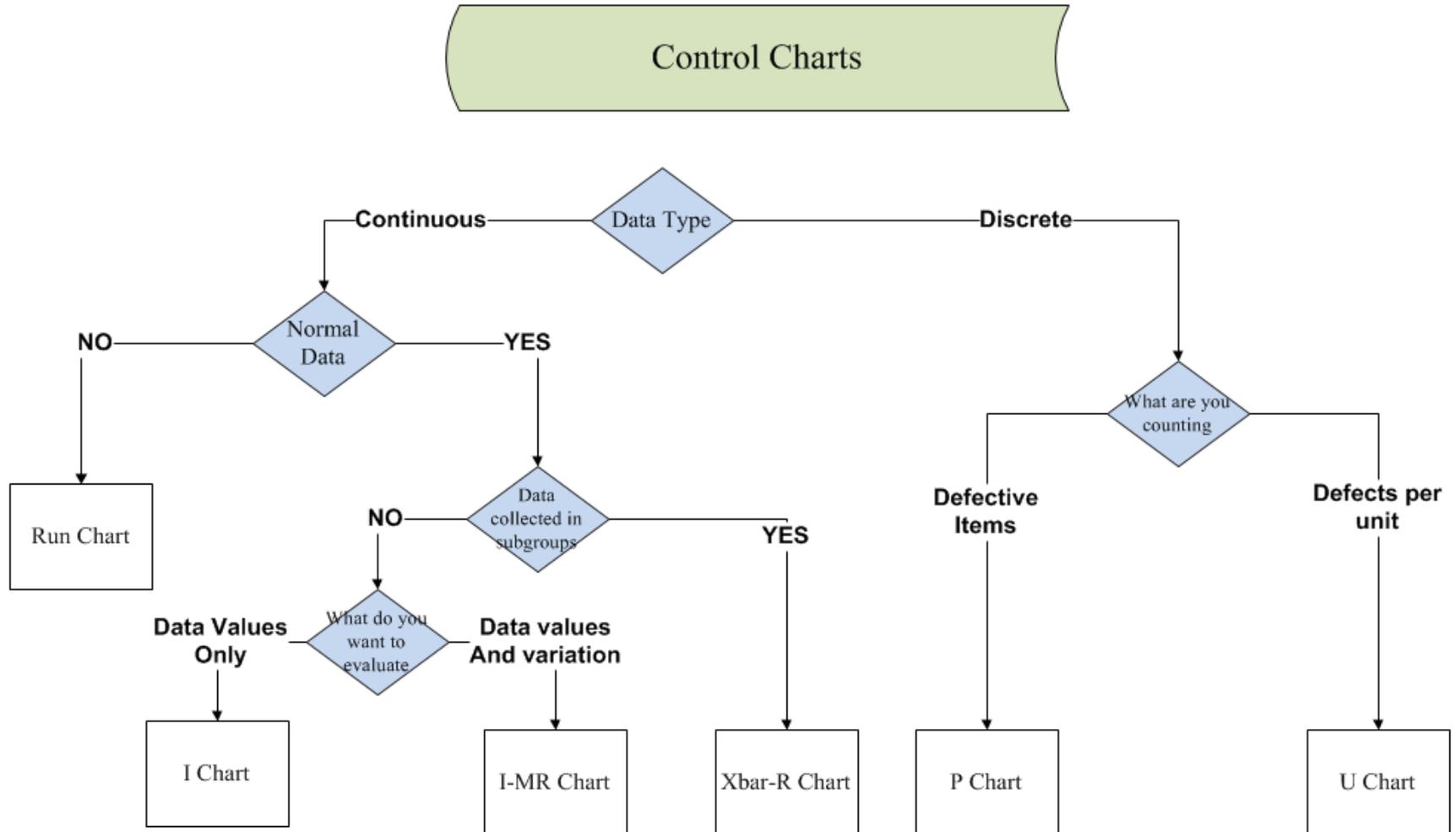
I see a pattern!

# Control Charts

- Is this process Out of Control?



# Control Chart Road Map



# This concept is simpler than it might seem...

- <https://www.youtube.com/watch?v=iWYIWE7SKcM>

# Questions?

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