Study Guide: Control Chart

This course provides a fundamental understanding of Control Charts and how to use them for process improvement. It will teach you how to determine if a process is experiencing common versus special cause variation and how to calculate control limits.

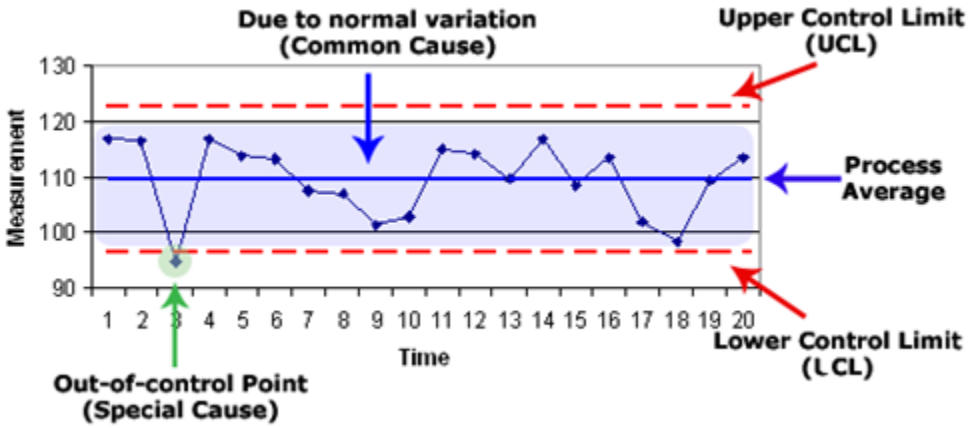
What is a Control Chart?

Control charts help distinguish between special and common cause variation.

Common cause variation - the inherent variation experienced by every process

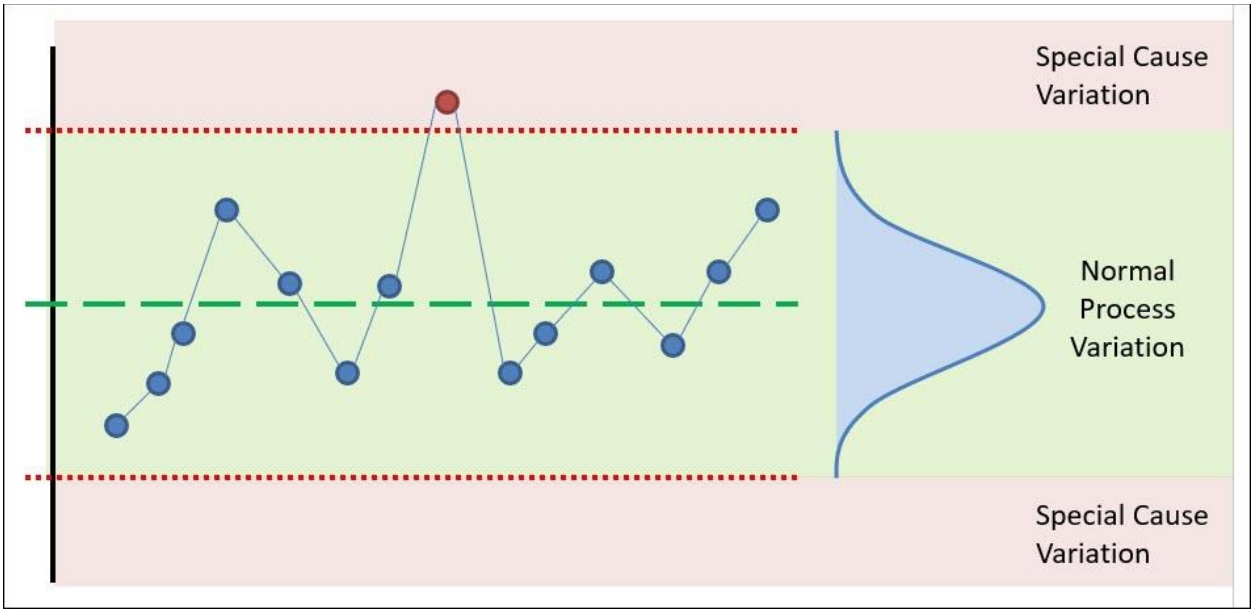
Special cause variation - variation that is not normal or inherent to the process

- Examples include:
  - Equipment that is wearing out over time
  - Vendor ships some non-conforming material
  - New operator



If special cause variation is detected, we should identify the root cause and improve the process.

The way we identify special cause variation is by using a control chart. We do this using upper and lower control limits, which creates boundaries between common and special cause variation.



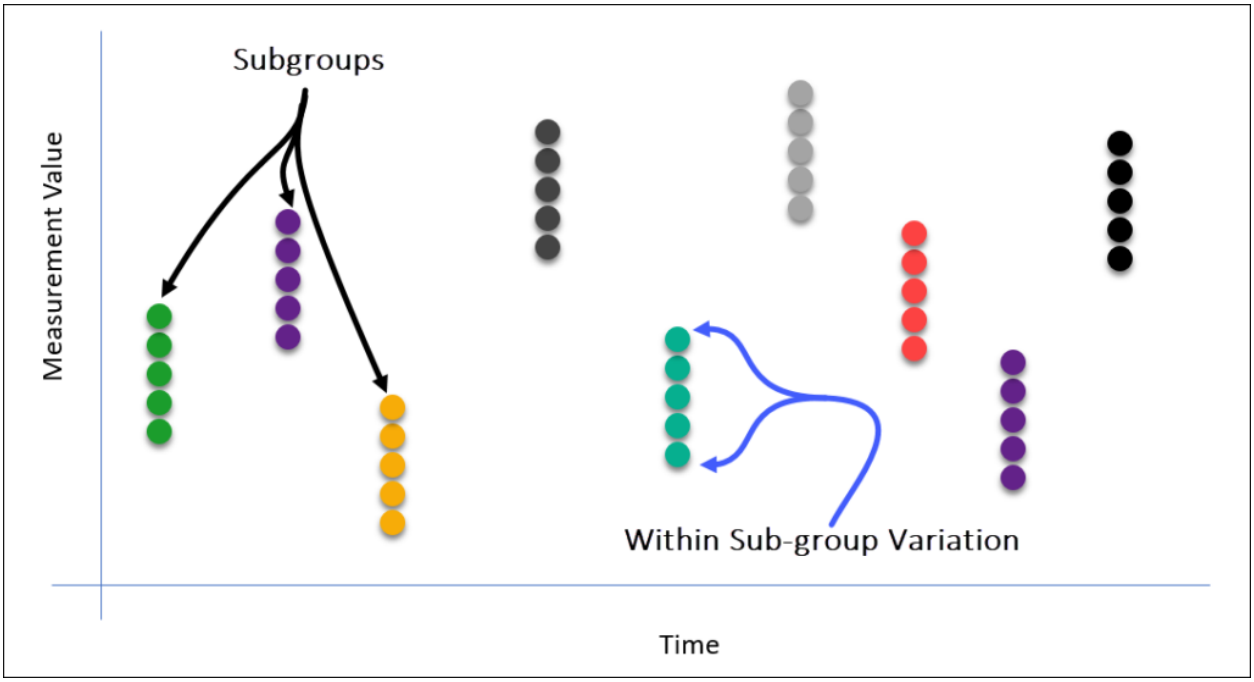
Everything that falls between the Upper and Lower Control limits is considered common cause variation. Likewise, everything outside of the control limits is considered common cause variation.

How to Calculate Control Limits on a Control Chart

A rational subgroup is defined as a collection of units that are all produced under the same conditions.

The Upper and Lower control limits for an X-bar chart includes the average range

The range value is used to calculate the Upper Control Limit for X-bar



A rational subgroup of datapoints must be collected while controlling all known variables

When creating control limits, all data collected should be done under the exact same operating conditions

By only including normal, inherent process variation in or rational subgroup, we ensure that our control limits are appropriately sensitive to special causes of variation

X-bar and R Chart Equations and Constants

The X-bar chart monitors the mean or average value of your process

The Range (R) Chart monitors the variation within your process

Special cause variation can either change the mean value or the variation of your process. Both should be monitored in order to detect special cause variation

The X-bar and R Chart Equations and Constants can be found in the following table:

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Tables of Constants for Control charts

Table 8A - Variable Data — ref : AIAG manual for SPC

	X bar and R Charts				X bar and s charts			
	Chart for Averages	Chart for Ranges (R)			Chart for Averages	Chart for Standard Deviation (s)		
	Control Limits Factor	Divisors to Estimate σ_x	Factors for Control Limits		Control Limits Factor	Divisors to estimate σ_x	Factors for Control Limits	
Subgroup size (n)	A_2	d_2	D_3	D_4	A_3	c_4	B_3	B_4
2	1.880	1.128	-	3.267	2.659	0.7979	-	3.267
3	1.023	1.693	-	2.574	1.954	0.8862	-	2.568
4	0.729	2.059	-	2.282	1.628	0.9213	-	2.266
5	0.577	2.326	-	2.114	1.427	0.9400	-	2.089
6	0.483	2.534	-	2.004	1.287	0.9515	0.030	1.970
7	0.419	2.704	0.076	1.924	1.182	0.9594	0.118	1.882
8	0.373	2.847	0.136	1.864	1.099	0.9650	0.185	1.815
9	0.337	2.970	0.184	1.816	1.032	0.9693	0.239	1.761
10	0.308	3.078	0.223	1.777	0.975	0.9727	0.284	1.716
15	0.223	3.472	0.347	1.653	0.789	0.9823	0.428	1.572
25	0.153	3.931	0.459	1.541	0.606	0.9896	0.565	1.435

	Centerline	Control Limits		σ_x
X bar and R Charts	$CL_{\bar{X}} = \bar{\bar{X}}$	$UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R}$	$LCL_{\bar{X}} = \bar{\bar{X}} - A_2\bar{R}$	$\frac{\bar{R}}{d_2}$
	$CL_R = \bar{R}$	$UCL_R = D_4\bar{R}$	$LCL_R = D_3\bar{R}$	
X bar and s Charts	$CL_{\bar{X}} = \bar{\bar{X}}$	$UCL_{\bar{X}} = \bar{\bar{X}} + A_3\bar{S}$	$LCL_{\bar{X}} = \bar{\bar{X}} - A_3\bar{S}$	$\frac{\bar{s}}{c_4}$
	$CL_s = \bar{s}$	$UCL_s = B_4\bar{s}$	$LCL_s = B_3\bar{s}$	

Make sure to find the constants that correspond with the subgroup sized used for sampling