$\bar{X}$-s Control Charts

The most common control chart for years has been the $\bar{X}$-R chart. This control chart uses the range to measure the variation within a subgroup. For the measurements within a subgroup, the range is the maximum – minimum value. The range is an easy concept to understand – and to calculate. This was important when the control chart calculations had to be done by hand or with a calculator. But with computer software, this is no longer an issue. One problem with the $\bar{X}$-R chart is that the range becomes a poorer and poorer measure of within subgroup variation as the subgroup size increases. A different method is needed for the larger subgroup sizes. This is where the $\bar{X}$-s chart provides the solution.

Purpose

The purpose of this module is to introduce the $\bar{X}$-s chart. This type of control chart is used with variables data – data that is taken along a continuum. Time, density, weight, and length are examples of variables data. Like most other variable control charts, it is actually two charts. One chart is for the subgroup averages ($\bar{X}$). The other chart is for the subgroup standard deviations (s).

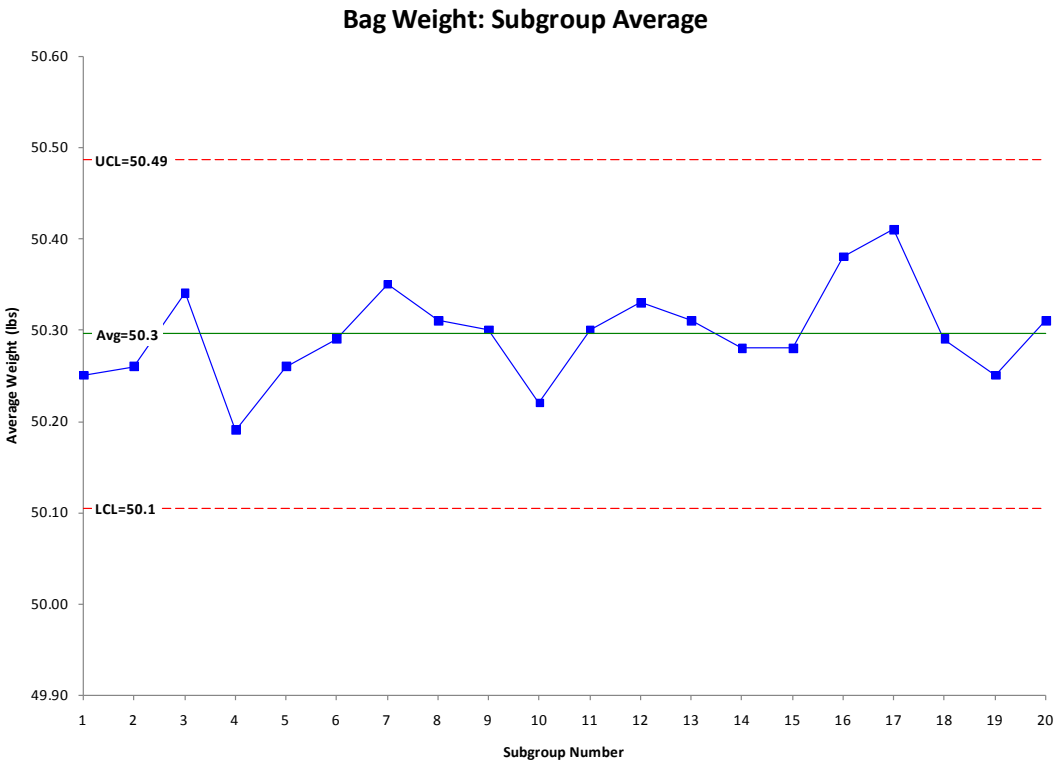
Understanding the $\bar{X}$-s Chart

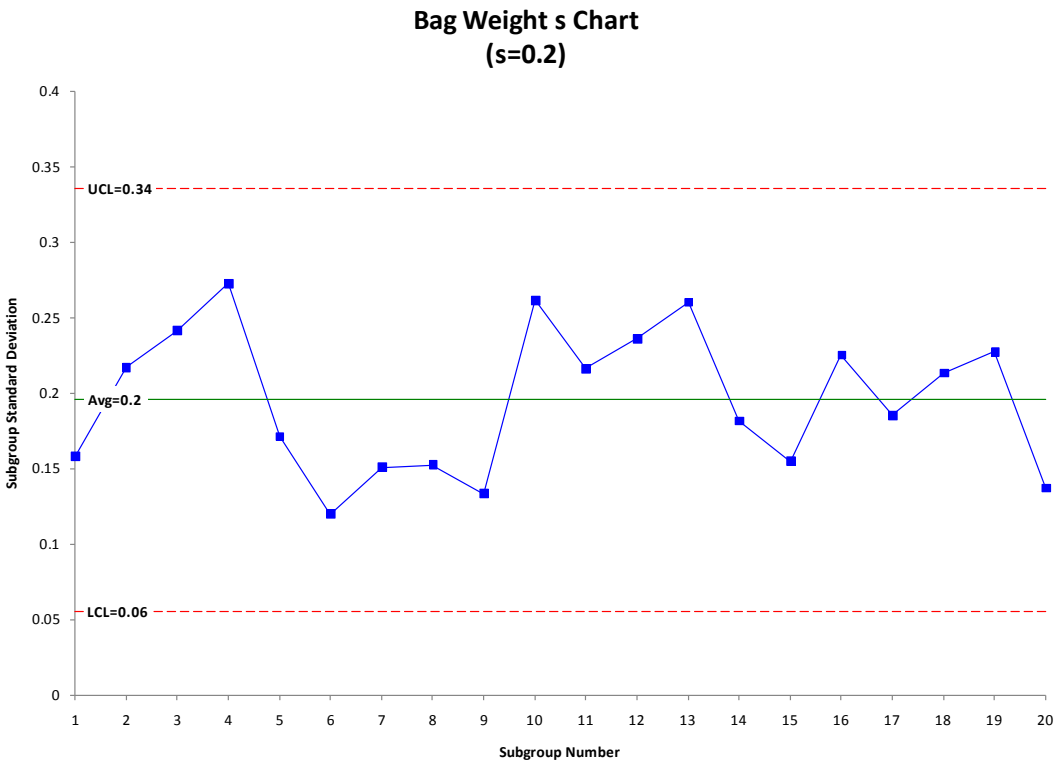
In the past, there has been reluctance to use the $\bar{X}$-s chart in place of the $\bar{X}$-R chart. The standard deviation is just not as easy to understand as the range. Plus, there was the calculation issue.

Yet, the $\bar{X}$-s chart is very similar to the $\bar{X}$-R chart. The major difference is that the subgroup standard deviation is plotted when using the $\bar{X}$-s chart, while the subgroup range is plotted when using the $\bar{X}$-R chart. One advantage of using the standard deviation instead of the range is that the standard deviation takes into account all the data, not just the maximum and the minimum. The constants used to calculate the control limits and to estimate the process standard deviation are different for the $\bar{X}$-s chart than for the $\bar{X}$-R chart. Like the $\bar{X}$-R chart, frequent data and a method of rationally subgrouping the data are required to use the $\bar{X}$-s chart.

Figure 1 is an example of an $\bar{X}$-s chart. A company is tracking performance of a bagging machine. Each bag should contain a minimum of 50 pounds (lbs) of sand. Ten bags are weighed at the start of each hour. This provides frequent data as well as a method of rationally subgrouping the data. The ten bags are used to form a subgroup, so the subgroup size (n) is 10. The average weight of the ten bags is calculated. This is the subgroup average ($\bar{X}$). The standard deviation of the ten bags is calculated. This is the subgroup standard deviation (s). The top part of Figure 1 is the $\bar{X}$ chart. The $\bar{X}$ values are plotted on this chart. Three lines are plotted on the $\bar{X}$ chart. The middle line is the overall process average ($\bar{\bar{X}}$); the upper line is the upper control limit; and the lower line is the lower control limit. The bottom part of Figure 1 is the s chart. The subgroup standard deviations are plotted on this chart. Three lines are plotted on this chart as well. The middle line is the average standard deviation ($\bar{s}$). The other two lines are the upper and lower control limits for the subgroup standard deviations.

Figure 1: Bag Weight $\bar{X}$-s Control Chart





$\overline{X}$ -s Charts

We must understand variation.

- Dr. W. Edwards Deming

SPC FOR EXCEL

Xbar-s Charts

- Most common chart for years: Xbar-R
  - Range for within group variation
  - Easy to understand
  - Easy to calculate
  - Not good for large subgroup sizes
- Need different method for larger subgroup sizes
- Answer: Xbar-s Charts

Standard Deviation or Range?

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