Graph

Points plotted: Sample means

Centerline: $\bar{\bar{x}}$ = mean of all sample means

Upper control limit (UCL): $\bar{\bar{x}} + A_2\bar{R}$ (where A_2 is found in Table 14-2)

Lower control limit (LCL): $\bar{\bar{x}} - A_2\bar{R}$ (where A_2 is found in Table 14-2)

Example 5 $\bar{x}$ Chart of Weights of Quarters

Using the weights of quarters in Table 14-1 with samples of size $n = 5$ for each of 20 days, construct a control chart for $\bar{x}$. Based on the control chart for $\bar{x}$ only, determine whether the process mean is within statistical control.

Solution

Before plotting the 20 points corresponding to the 20 values of $\bar{x}$, we must first find the values for the centerline and control limits. We get

$$\bar{\bar{x}} = \frac{5.6334 + 5.6972 + \cdots + 5.8170}{20} = 5.6955$$

$$\bar{R} = \frac{0.155 + 0.186 + \cdots + 0.602}{20} = 0.2054$$

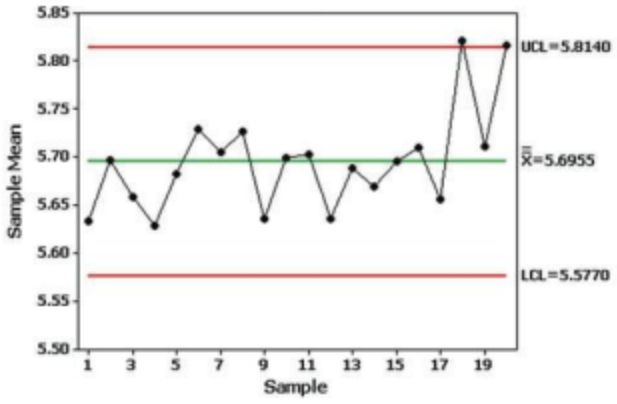
Referring to Table 14-2, we find that for $n = 5$, $A_2 = 0.577$. Knowing the values of $\bar{\bar{x}}$, A_2, and $\bar{R}$, we can now evaluate the control limits.

Upper control limit: $\bar{\bar{x}} + A_2\bar{R} = 5.6955 + (0.577)(0.2054) = 5.8140$

Lower control limit: $\bar{\bar{x}} - A_2\bar{R} = 5.6955 - (0.577)(0.2054) = 5.5770$

The resulting control chart for $\bar{x}$ will be as shown in the accompanying Minitab display.

$\bar{x}$ CHART



Interpretation

Examination of the $\bar{x}$ chart shows that the process mean is out of statistical control because at least one of the three out-of-control criteria is not satisfied. Specifically, the second criterion is violated because there are points lying beyond the control limits.

Bribery Detected with Control Charts

Control charts were used to help convict a person who bribed Florida jai alai players to lose. (See "Using Control Charts to Corroborate Bribery in Jai Alai," by Charnes and Gitlow, *The American Statistician*, Vol. 49, No. 4.) An auditor for one jai alai facility noticed that abnormally large sums of money were wagered for certain types of bets, and some contestants didn't win as much as expected when those bets were made. *R* charts and $\bar{x}$ charts were used in court as evidence of highly unusual patterns of betting. Examination of the control charts clearly shows points well beyond the upper control limit, indicating that the process of betting was out of statistical control. The statistician was able to identify a date at which assignable variation appeared to stop, and prosecutors knew that it was the date of the suspect's arrest.