Don't Tamper!

Nashua Corp. had trouble with its paper-coating machine and considered spending a million dollars to replace it. The machine was working well with a stable process, but samples were taken every so often and, based on the results, adjustments were made. These overadjustments, called *tampering*, caused shifts away from the distribution that had been good. The effect was an increase in defects. When statistician and quality expert W. Edwards Deming studied the process, he recommended that no adjustments be made unless warranted by a signal that the process had shifted or had become unstable. The company was better off with no adjustments than with the tampering that took place.

- Two out of three consecutive points are beyond control limits that are 2 standard deviations away from the centerline.
- Four out of five consecutive points are beyond control limits that are 1 standard deviation away from the centerline.

Example 4 Interpreting *R* Chart of Weights of Quarters

Examine the *R* chart shown in the display for Example 3 and determine whether the process variation is within statistical control.

Solution

We can interpret control charts for *R* by applying the three out-of-control criteria just listed. Applying the three criteria to the display of the *R* chart, we conclude that variation in this process is not within statistical control. (1) Because the points at the end appear to show an upward trend, there is an obvious pattern that is not random. (2) The last two points are lying outside of the region between the upper and lower control limits. (3) The first eight points are eight consecutive points all lying below the centerline.

Interpretation

We conclude that the *variation* (not necessarily the mean) of the process is out of statistical control.

Control Chart for Monitoring Means: The $\bar{x}$ Chart

An **$\bar{x}$ chart** is a plot of the sample means, and it is used to monitor the *center* in a process. In addition to plotting the sample means, we include a centerline located at $\bar{\bar{x}}$, which denotes the mean of all sample means (equal to the mean of all sample values combined), as well as another line for the lower control limit and a third line for the upper control limit. Using the approach common in business and industry, the control limits are based on ranges instead of standard deviations. (See Exercise 14 for an $\bar{x}$ chart based on standard deviations.)

Monitoring Process Mean: Control Chart for $\bar{x}$

Objective

Construct a control chart for $\bar{x}$ (or an $\bar{x}$ chart) that can be used to determine whether the *center* of process data is within statistical control.

Requirements

1. The data are process data consisting of a sequence of samples all of the same size n.
2. The distribution of the process data is essentially normal.
3. The individual sample data values are independent.

Notation

n = size of each sample, or *subgroup*

$\bar{\bar{x}}$ = mean of all sample means (equal to the mean of all sample values combined)