14-2 Beyond the Basics

13. *s* Chart In this section we described control charts for R and $\bar{x}$ based on ranges. Control charts for monitoring variation and center (mean) can also be based on standard deviations. An *s chart* for monitoring variation is constructed by plotting sample standard deviations with a centerline at $\bar{s}$ (the mean of the sample standard deviations) and control limits at $B_4\bar{s}$ and $B_3\bar{s}$, where B_4 and B_3 are found in Table 14-2 in this section. Construct an s chart for the data of Table 14-1. Compare the result to the R chart given in Example 3.

14. $\bar{x}$ Chart Based on Standard Deviations An $\bar{x}$ chart based on standard deviations (instead of ranges) is made by plotting sample means with a centerline at $\bar{\bar{x}}$ and control limits at $\bar{\bar{x}} + A_3\bar{s}$ and $\bar{\bar{x}} - A_3\bar{s}$, where A_3 is found in Table 14-2 and $\bar{s}$ is the mean of the sample standard deviations. Use the data in Table 14-1 to construct an $\bar{x}$ chart based on standard deviations. Compare the result to the $\bar{x}$ chart based on sample ranges (as in Example 5).

Quality Control at Perstorp

Perstorp Components, Inc., uses a computer that automatically generates control charts to monitor the thicknesses of the floor insulation the company makes for Ford Rangers and Jeep Grand Cherokees. The $20,000 cost of the computer was offset by a first-year savings of $40,000 in labor, which had been used to manually generate control charts to ensure that insulation thicknesses were between the specifications of 2.912 mm and 2.988 mm. Through the use of control charts and other quality-control methods, Perstorp reduced its waste by more than two-thirds.

14-3 Control Charts for Attributes

Key Concept Section 14-2 described methods for constructing control charts used to monitor the variation and mean of process data, but this section presents a method for constructing a control chart to monitor the proportion p for some *attribute,* such as whether a service or manufactured item is defective or nonconforming. (A good or a service is nonconforming if it doesn't meet specifications or requirements. Nonconforming goods are sometimes discarded, repaired, or called "seconds" and sold at reduced prices.) The control chart is interpreted using the same three criteria from Section 14-2 to determine whether the process is statistically stable. As in Section 14-2, we select samples of size n at regular time intervals and plot points in a sequential graph with a centerline and control limits. (There are ways to deal with samples of different sizes, but we don't consider them here.)

DEFINITION A **control chart for *p*** (or ***p* chart**) is a graph of proportions of some attribute (such as whether products are defective) plotted sequentially over time, and it includes a centerline, a lower control limit (LCL), and an upper control limit (UCL).

The notation and control chart values are as summarized in the following box. In this box, the attribute of "defective" can be replaced by any other relevant attribute (so that each sample item belongs to one of two distinct categories).

Monitoring a Process Attribute: Control Chart for *p*

Objective

Construct a control chart for p (or a "p chart") that can be used to determine whether the proportion of some attribute (such as whether products are defective) from 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. Each sample item belongs to one of two categories (such as defective or not defective).
3. The individual sample data values are independent.