DEFINITIONS A **control chart** (or **Shewhart chart** or **process-behavior chart**) of a process characteristic (such as mean or variation) consists of values plotted sequentially over time, and it includes a **centerline** as well as a **lower control limit** (LCL) and an **upper control limit** (UCL). The centerline represents a central value of the characteristic measurements, whereas the control limits are boundaries used to separate and identify any points considered to be *unusual*.

We will assume that the population standard deviation σ is not known as we now consider two of several different types of *control charts:*

1. R charts (or range charts) used to monitor variation
2. $\bar{x}$ charts used to monitor means

When using control charts to monitor a process, it is common to consider R charts and $\bar{x}$ charts together, because a statistically unstable process may be the result of increasing *variation,* changing *means,* or both.

An ***R* chart** (or **range chart**) is a plot of the sample ranges instead of individual sample values, and it is used to monitor the *variation* in a process. It might make more sense to use standard deviations, but range charts are quite effective for cases in which the size of the samples (or subgroups) is 10 or fewer. If the samples all have a size greater than 10, the use of an s chart is recommended instead of an R chart. (See Exercise 13.) In addition to plotting the values of the ranges, we include a centerline located at $\bar{R}$, which denotes the mean of all sample ranges, as well as another line for the lower control limit and a third line for the upper control limit. The following is a summary of notation and the components of the R chart.

Monitoring Process Variation: Control Chart for *R*

Objective

Construct a control chart for R (or an "R chart") that can be used to determine whether the *variation* 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*

$\bar{R}$ = mean of the sample ranges (the sum of the sample ranges divided by the number of samples)

Graph

Points plotted: Sample ranges (one point representing the range for each sample or subgroup)

Centerline: $\bar{R}$ (the mean of the sample ranges)

Upper control limit (UCL): $D_4\bar{R}$ (where D_4 is found in Table 14-2)

Lower control limit (LCL): $D_3\bar{R}$ (where D_3 is found in Table 14-2)