



Control Chart Sensitivity

by John J. Flaig, Ph.D.

Dr. Montgomery notes that, "A major disadvantage of any Shewhart control chart is that it only uses the information about the process contained in the last plotted point, and it ignores any information given by the entire sequence of points." This fact makes these charts insensitive to small changes in the characteristic under study (say changes of less than 1.5σ because the power of the test is small). There are three approaches to solving this problem.

1. You can add a number of runs rules (e.g., 2 out of 3 points, on the same side of the CL and outside 2σ). However, this reduces the in-control average run length (ARL_0), which is not desirable because it results in an increase in the false alarm rate.

2. You can choose a Cumulative Sum (Cusum) or Exponentially Weighted Moving Average (EWMA) control chart both of which utilizes historical data and hence are sensitive to small changes in the process characteristic. However, these charts do not provide a picture of the process so they don't provide a good communication tool. In addition, their out-of-control (ARL_1) performance is significantly poorer than the next alternative.

3. You can choose an adaptive Shewhart control chart. Adaptive control charts are charts in which the sample size or sampling frequency changes based on observed process behavior. These charts were first proposed by Dr. Reynolds, et al. (for mean charts) and the author (for mean and Cusum charts) in 1988. The advantage of the adaptive Shewhart chart is that it continues to be an excellent communication tool, because it provides a graphic picture of the process and its sensitivity to small shifts is significantly enhanced. For example, the adaptive Shewhart chart has significantly better (larger) ARL_0 than the Cusum chart and it has better (smaller) out-of-control (ARL_1) performance than the Cusum chart for shifts greater than about $.2\sigma$ (see Figure 1 below). So you can have your cake and eat it too.

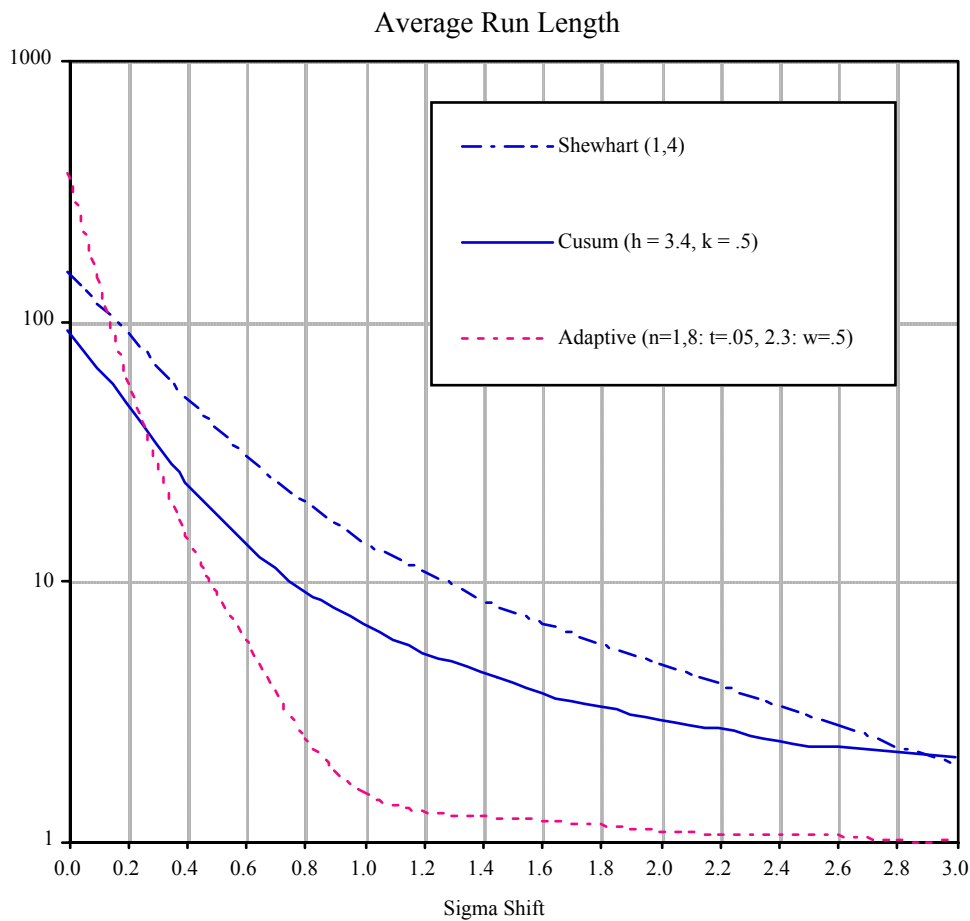


Figure 1. ARL Comparison of Various Control Charts

Montgomery, D. C. (2001). Introduction to Statistical Quality Control. 4 Ed., John Wiley and Sons, New York, NY.

Reynolds, M. R. Jr., Amin, R. W., Arnold, J. C., and Nachlas, J. A. (1988). \bar{X} Charts with Variable Sampling Intervals. Technometrics, Vol. 30.

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