Advanced Topics in Statistical Process Control

The Power of Shewhart's Charts

Second Edition

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The Shewhart Catechism

1. *What if a state of predictability is beyond the capability of our process?*
   This cannot happen. A process is operating predictably when it is being operated as consistently as it can—no more, and no less. See Sections 1.1, 1.2

2. *Is quality defined by conformance to specifications?*
   No. Today world-class quality is defined as "on-target with minimum variance." Conformance to specifications is merely the starting point, not the finish line.
   See Section 8.6

3. *What do capability ratios do?*
   Capability ratios may be used to compare the Voice of the Process with the Voice of the Customer. However, it is easy to go overboard with this. Some other measures are also useful, and no numerical summary is an adequate replacement for the basic graphs of the data. See Section 8.3

4. *How do Dr. Deming's 14 Points relate to Statistical Process Control?*
   They may be thought of as corollaries to the observation that organizations do not behave in a rational manner and therefore cannot effectively use the knowledge gained from the charts. See Section 1.6

5. *How do Shewhart's process behavior charts differ from tests of hypotheses?*
   Shewhart's charts characterize a time series as being either predictable or unpredictable. When a test of hypotheses is applied to a time series it *presumes* the time-series to be predictable, and looks for changes in parameters of the predictable time-series. See Sections 1.3 through 1.5 and Chapter 19

6. *Does it matter how we calculate the limits of a process behavior chart?*
   Yes. There are right and wrong ways of computing limits. While *all* of the right ways will yield essentially the same limits, the wrong ways will result in incorrect limits and faulty decisions. See Section 3.2

7. *Do we have to remove the "outliers" from the data before we calculate the limits?*
   No. The correct computational procedures for process behavior chart limits are not severely affected by outliers. See Sections 3.2 and 4.1

8. *Must the data "be in control" prior to placing them on a process behavior chart?*
   No. One purpose of a process behavior chart is to detect the presence or absence of a state of predictability. Therefore, you do not have to wait for "pristine" data, nor do you have to clean up the data prior to computing the limits.
   See Section 3.2 and Chapter 4

9. *How can we calculate good limits from data which are "out of control?"*
   The correct approaches to computing limits will minimize the impact of exceptional variation upon the limits. See Chapter 4

10. *Should we calculate limits for the Average Chart when the Range Chart is unpredictable?*
    Yes. You will not discover anything by *not* calculating limits!
    See Sections 4.1 and 5.4

11. *Can we use two-sigma limits?*
    No. Two-sigma limits are inappropriate for a process behavior chart. See Section 10.4

12. *Do three-sigma limits depend upon having normally distributed data?*
    No. Three-sigma limits are sufficiently general to work with virtually any distribution. See Sections 5.1 and 5.2

13. *Are the process behavior chart constants dependent upon having normally distributed data?*
    No. These constants are remarkably similar for a wide range of different distributions. See Section 5.4

14. *Do we have to wait until we have 25 or 30 subgroups before calculating limits?*
    No. Limits may be calculated using small amounts of data. The degrees of freedom will characterize just how "reliable" the calculated limits have become.
    See Sections 3.6, 5.4, and 7.9

15. *What about data which display autocorrelation?*
    Shewhart placed autocorrelated data on charts. You can too. See Chapter 12

16. *Do we have to use subgroups of size 5?*
    No. The subgroup size is not the most important characteristic of the chart. Rational subgrouping is more important than the subgroup size, even if that requires subgroups of size one. See Sections 1.6, 10.1, and Chapter 6

17. *What is a rational subgrouping?*
    Among other things, a rational subgrouping is one in which the measurements inside each subgroup are judged to have been obtained under essentially the same conditions. Moreover, the subgrouping must respect the structure of the data.
    See Section 1.2 and Chapter 6

18. *Does the Central Limit Theorem require charts to use subgroups of size 4 or 5?*
    While the Central Limit Theorem is true, it is not the basis on which the process behavior chart is built. Therefore, this theorem cannot *require* anything of a process behavior chart. The charts will work with subgroups of size 1, and they will do so even when the data are not normally distributed. See Sections 5.2, 10.1, and 10.3

19. *Does a subgroup always consist of consecutive measurements?*
    No. While many processes may be tracked using subgroups of consecutive measurements, this is not a requirement of the chart. Once again, it is more important that the subgrouping be rational. See Section 1.6 and Chapter 6

20. *What happens to a process behavior chart when the measurement units are too large to detect the variation in the data?*
    False alarms will proliferate. This problem is easy to spot, but it must be considered if you are to avoid looking for nonexistent assignable causes. See Section 5.5

21. *Why do we use so many symbols for dispersion?*
    There is a multiplicity of dispersion statistics as well as a plurality of dispersion parameters. A lack of a standard nomenclature here is a real source of confusion.
    See Sections 3.1 through 3.4

22. *Is the standard deviation statistic better than the range?*
    Not for small subgroup sizes. See Sections 4.1, 4.3, and Appendix Tables 18, 19, and 20

23. *Is not the Pooled Variance a better measure of dispersion than the Average Standard Deviation or the Average Range?*
    Yes and No. The Pooled Variance will have more degrees of freedom than the other measures, but it will be more severely affected by a lack of homogeneity than will the other measures. See Sections 3.4 and 7.7

24. *What are Degrees of Freedom?*
    Degrees of Freedom is the name given to a characterization of the variation of a measure of dispersion. The greater the Degrees of Freedom, the smaller the variation of the measure of dispersion. See Sections 3.6, 7.7, 7.8, and 7.9

25. *How do we measure dispersion when our subgroup size is one?*
    We must use a two-point moving range to measure dispersion when placing a time series of individual values on a process behavior chart. See Sections 3.5 and 4.6

26. *What role does the Moving Range Chart play with an Individual Value Chart?*
    It signals that the user knows the correct way of computing limits, it identifies breaks in the original time series, and it provides those who look at the chart with the ability to easily check that the computation of the limits is correct.
    See Section 4.6

27. *Are "unbiased" estimators better than "biased" estimators?*
    No. The property of being unbiased does not imply closeness to the parameter.
    See Section 3.1

28. *Should I be using the skewness and kurtosis values from my printout?*
    No. You will never have enough data to make these "shape statistics" useful.
    See Section 2.4

29. *Will Chaos Theory replace process behavior charts?*
    No. Since Dr. Shewhart's approach is holistic and empirical, it can accommodate the paradigm shift represented by the new theories of quasi-chaotic variation.
    See Section 1.7

30. *What about transforming the data prior to placing them on a chart?*
    Transformations to achieve a quasi-normal histogram or transformations to achieve other statistical properties are not recommended. They introduce more complexity than they are worth. Transformations to achieve *clarity of interpretation* are always appropriate. See Sections 1.8, 6.1, 11.9, and Chapter 19

31. *Is a Moving Average Chart better than a chart for Individual Values?*
    Only occasionally. Most times the Individual Value Chart will be the better chart.
    See Section 10.3

32. *What is the difference between Attribute Charts and XmR Charts?*
    XmR Charts use empirical limits while Attribute Charts use theory to construct limits. Therefore, with Attribute Charts you must check to see if the theory is appropriate.
    See Chapter 11

33. *How can we chart rare events?*
    Counts of rare events will result in weak charts. It is better to measure the area of opportunity between the rare events and use these measurements on the charts.
    See Section 11.9

34. *Is it true that the Cumulative Sum (Cusum) is better than a process behavior chart?*
    No. The Cusum technique may be easier to program than a process behavior chart, but contrary to much of what has been written, it does not really work any better than process behavior charts. Moreover, by transforming the original data, the Cusum technique can actually obscure that which is easily seen in the running records of the process behavior charts. See Chapter 13

35. *Can we use an Exponentially Weighted Moving Average instead of a process behavior chart?*
    An EWMA attempts to model a time series. Such models may be used for process monitoring. However, EWMAs are no more sensitive than a process behavior chart, they will always lag behind a chart, and they are more complex than a chart.
    See Chapter 14

36. *Can we use PreControl instead of a process behavior chart?*
    No. PreControl is totally different from a process behavior chart, and inferior as well.
    See Section 16.3

37. *Are Zone Charts a valid alternative to a process behavior chart?*
    No. Zone charts result in too many false alarms. In addition, they are actually more complex than a process behavior chart, while providing nothing more than a parody of the process behavior chart.
    See Section 16.1