

Tim Wangler
Dr. Foster
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Attribute Control Charts

INTRODUCTION: Attribute control charts can be used to monitor the stability of systems where any count or percentage is accumulated. Attribute charts are the result of an assessment using go/no go gauges, or pass fail criteria.

Attribute charts consist of:

- p chart (Graph of fraction non-conforming)
- np chart (Graph the number of non-conformances in a sample of n pieces)
- u chart (Graph the defect count / n)
- c chart (Graph the defects in a sample of n pieces)

p and np charts are used to graph non-conformities. c and u charts are used to graph non-conforming units. The distinction is paramount to understand, and is described in the next section.

An attribute control chart is reactive to a process, graphing the non-conformities, or non-conforming units. An important distinction must be made regarding non-conformities and non-conforming units. “Non-conformity may be a blemish or the presence of some non-preferred feature” (Freeman, Mintzas, 2). A non-conforming unit on the other hand is defined as, “A non-conforming unit, however, may fail to meet the assessment of some criteria because of one or more non-conformities” (Freeman, Mintzas, 2).

The relationship between quality and attribute charts is one where the attribute chart is one more tool in the manager’s tool box in fighting the productivity killers like scrap and rework. Reducing scrap and rework can increase productivity, decrease cost,

and decrease production capacity. “By interpreting control chart patterns, the manufacturing manager can help reduce non-conformities and rejections that occur on-line and thus assist with the prevention of quality problems” (Freeman, Mintzas, 2).

One important tip when computing attribute charts is to make sure the, accept/reject boundaries are clearly defined. This will eliminate any ambiguity when performing the necessary analysis on the particular item being sampled. Also, the accept/reject characteristics should be agreed with by the customer.

HOW TO USE ATTRIBUTE CHARTS: Attribute charts start with a sample of items. These items could be letters about to be mailed, bottles of beer, widgets, wajamas, whatever your firm needs to look at. Then it is required to look at the number of non-conformities or, non-conforming units, depending on what type of chart you are calculating. In the case of sampling bottles of beer if there was a scuff on the label that would be non-conformity and the chart desired would be either a c or u chart. However, if the problem lies with the taste of the beer then the entire unit is defective and the desired chart would be a p chart or np chart.

In the case of p and np charts the next step is to summate the column of data that contain the proportion of defective items called \bar{p} and then compute \bar{p} . \bar{p} is equal to the average number defective. The upper and lower control limits are computed using \bar{p} . The basic calculation for p charts is $p = \bar{p} \pm 3\sqrt{\bar{p}(1-\bar{p})/n}$. Some important variables that need to be calculated for p charts are:

1. \bar{p} is the proportion defective.
2. \bar{p} is the average proportion defective.
3. n is the sample size.

The main difference between p and np charts is that with np charts the sample size must be the same number for every sample. The p chart allows for different sample size, because of this \bar{n} or the average sample size is also required to be calculated.

np charts are calculated much the same way as p charts, with one exception, the standard error must be calculated. The standard error is calculated with the formula, $S_{np} = \sqrt{\bar{np}(1-\bar{np}/n)}$. The control limits are calculated with the formula, $n(\bar{p}) \pm 3S_{np}$.

Some common variables with np charts are:

1. n is the sample size.
2. \bar{p} is the average proportion defective.
3. S_{np} is the standard error.

c and u charts look at non-conformities, and specifically the c chart graphs the number of defects, and the u chart graphs the average number of defects. The formula for the control limits for the c and u chart are, $CL_c = \bar{c} \pm 3\sqrt{\bar{c}}$, $CL_u = \bar{u} \pm 3\sqrt{\bar{u}/n}$.

The required variables needed to calculate c and u charts are:

1. n is the average sample size.
2. \bar{c} is the process average number of non-conformities.
3. \bar{u} is the process average number of non-conformities per unit.

EXAMPLE: An example of a p chart is given.

The Boise Cascade corporation is implementing new process for writing purchase orders (PO's). The implementation of the new system has not taken well. Personnel

authorized to write PO's are using the new system wrong, and consequently writing defective PO's. A graph and the proper calculations are in figure 1.

The conclusion can be reached that the process is not stable . This can be seen by looking at the two points that fall below the lower control limit, signifying the process is statistically not stable. Therefore, action must be taken. That action can be additional training using the system, or gathering user input to determine what the problem is. The point is attribute control charts tell you when to take action on a situation and when to leave the system alone. Although this tutorial only went through the p chart, the calculation of np, c, and u charts are computed much the same way as the p chart.

As the use of computers grows increasingly common in the manufacturing environment control charts will be pushed downward and not only used by engineers but by factory floor workers. Control charts provide instantaneous feedback about the stability of a system which can be useful to the floor worker. "Attribute data can be collected from any type of process. Several types of non-conformities can be grouped together on one chart, and the charts can be easily interpreted" (Zaciewski, 2).

WHERE TO GET MORE INFORMATION: The *Journal of Quality Management* has a consistent amount of writings concerning control charts. Also, *The TQM Magazine* has contains many articles about both attribute control charts and variable control charts. Both publications provide articles that are accessible over the internet.

Bibliography

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