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Making and Interpreting Run Charts

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Definition:

A run chart is a graphical display of data over time.

Application:

Run charts are used to analyze processes according to time or order. Run charts are useful in discovering patterns in data that can occur over time.

Creation:

To begin any run chart, some type of process or operation must be available to take measurements for analysis. Measurements must be taken over a reasonable period of time using a calibrated measurement tool which is being monitored with a calibration control chart. A gage R&R study must indicate that the measurement process is acceptable before collecting data. The data must be collected in a chronological or sequential order. You may start at any point and end at any point. For best results, at least 25 or more samples must be taken in order to get a reasonable good run chart.

Once the data has been placed in chronological or sequential order, it must be divided into two sets of values x and y. The values for x represent time and the values for y represent the measurements taken from the process.

Plot the y values versus the x values by hand or by using a computer program. Select an appropriate scale that will make the points on the graph visible. Next, draw vertical lines for the x values to separate time intervals such as days, weeks, months, etc. Then draw horizontal lines to help distinguish where non-random observations appear (i.e., trends, shifts, spikes, cycles, etc.) in the process or operation.

Graph:

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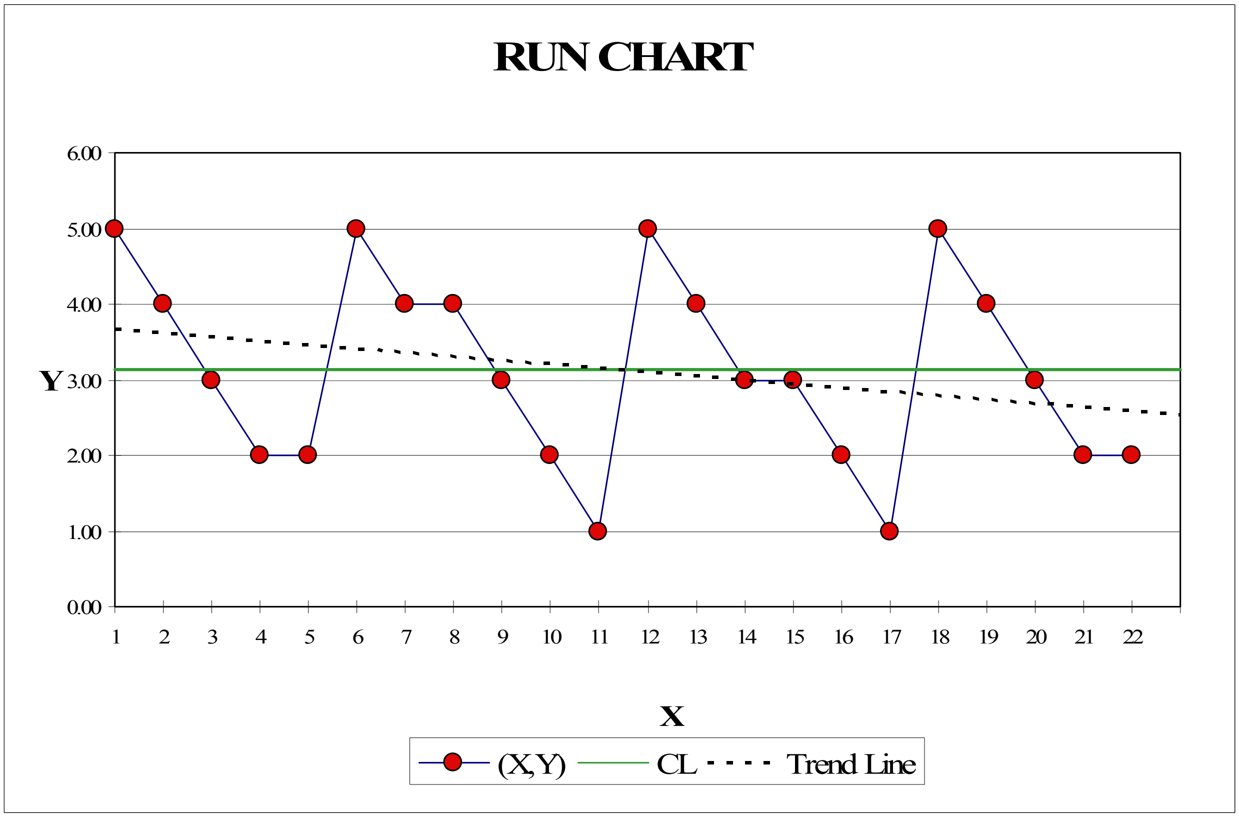

Interpretation:

To effectively interpret a run chart the practitioner should do the following:

1. Draw a linear trend line from the beginning to the end of the data on the graph. If the line is approximately horizontal, then the mean of the process can be considered stationary over this time interval. If not, then the process mean is considered non-stationary or unstable. Remember, that drawing this inference requires sufficient data (we recommend that you have more than 50 observations).

2. Look at the graph, does it appear that the variation in the data is increasing or decreasing over time (i.e., Does the overall pattern appear funnel shaped or like a snake that swallowed a pig?). If the answer is yes, then the process variance can be considered non-stationary. If the answer is no, then the process variance can be considered stationary.

3. Look at the graph, are the points scattered evenly and randomly around the trend line? If the answer is yes, then the data is not significantly autocorrelated (i.e., it is reasonably independent). If the answer is no, then the data may be autocorrelated (i.e., It may not be independent. Is there a logical reason why this would be the case? Think about it).

4. Look at the graph, is there a pattern in the data (e.g., cyclic, trend, shift, spike, funnel shape, etc.)? To help spot a change, draw a horizontal line from the beginning of the data to the end dividing the data in half. This is called the center line (CL) or median of the data. If you find cases where eight or more consecutive points are above or below the median line, or if eight points are steadily increasing or decreasing, then the process is unstable. If the answer is yes, then the process can be considered non-random and you should look for the cause(s). If the answer is no, then the data can be considered random.

5. Look at the graph; is there a point or points that appear to be isolated from the rest of the data? If the answer is yes, then investigate this observation to determine its validity and the cause(s).

Analysis of the Graph Above:

1. The process mean may be slightly nonstationary (i.e., the trend line is going down), but the small number of observations and the large amount of variation in the data make it impossible to validate this trend with a high degree of confidence. We should continue to monitor the process to see if the trend continues and becomes significant.

2. The process variance appears to be stationary, as the envelope of variation seems to be fairly consistent.

3. There appears to be autocorrelation in the data since the points do not appear to be randomly distributed around the trend line.

4. There appears to be a cyclic pattern of period 5 in the data. There does not appear be a trend, shift, spike, or any other unusual pattern in the data.

5. There do not appear to be any "outliers" or rare event points in the data.

Summary:

The Run Chart can be a very effective tool in understanding process behavior. The smart Engineer will make it one of their commonly used tools.

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