

## Run Charts

Adding the element of time will help clarify your understanding of the causes of variation in your processes. A run chart is a line graph of data points organized in time sequence and centered on the median data value. The patterns in the run chart can help you find where to look for assignable causes of variation.

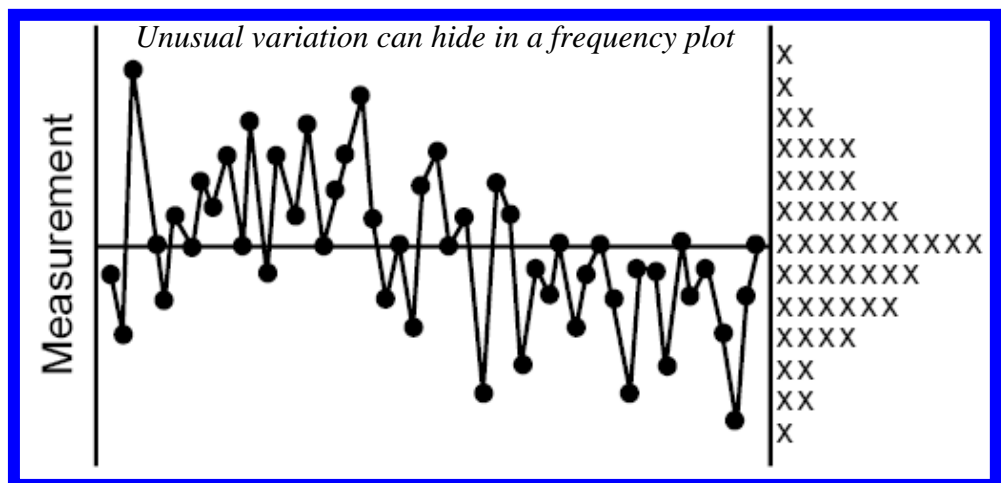


*"I say we can get outta here by five if we just spin the charts 180 degrees before they come in."*

### **What can it do for you?**

Histograms or frequency plots can show you the general distribution or variation among a collection of data points representing a process, but one histogram or one frequency plot can not show you trends or help pinpoint unusual events. Sometimes, a normal-looking distribution will hide trends or other unusual data. To spot those trends, the data must be considered in time order. Plotting data on a run chart can help you identify trends and relate them to the time they occurred. This will help you in your search for the special causes that may be adding variation to your process.

Run charts are especially valuable in the *measure and analyze* phases of Lean Six Sigma methodology.



## How do you do it?

1. **Select a characteristic from one of your processes.** This characteristic could be presenting a problem because excessive variation often drives it outside of specification limits, or it could be a cause of customer complaints.
2. **Measure the characteristic over time intervals and record the data.** Note the time or the time period that is associated with each data point.
3. **Find the median data value.** To do this, list the data values in numeric order. Include each data point, even if it is a repeat value. If the number of data points is odd, the median is the middle value. If the number of data points is even, the median is halfway between the two values nearest the middle. For example, if the collected data points were: 5, 1, 18, 8, 12, 9, the ordered values would be: 1, 5, 8, 9, 12, and 18. The middlemost values are 8 and 9. The median is the average of those values, or 8.5. (Remember, the numerically-ordered data is only for determining the median. The data must be plotted in time order on the run chart to be of any value.)
4. **Set up the scales for your run chart.** The vertical scale will be the data values, and the horizontal scale will be the time. Make the horizontal scale about two to three times the distance of the vertical scale.
5. **Label the vertical scale** so that the values will be centered approximately on the median and so the scale is about 1 ½ to 2 times the range of the collected data.
6. **Draw a horizontal line representing the median value.**
7. **Plot the data points in sequence.** Connect each point to the next point in the sequence with a line.

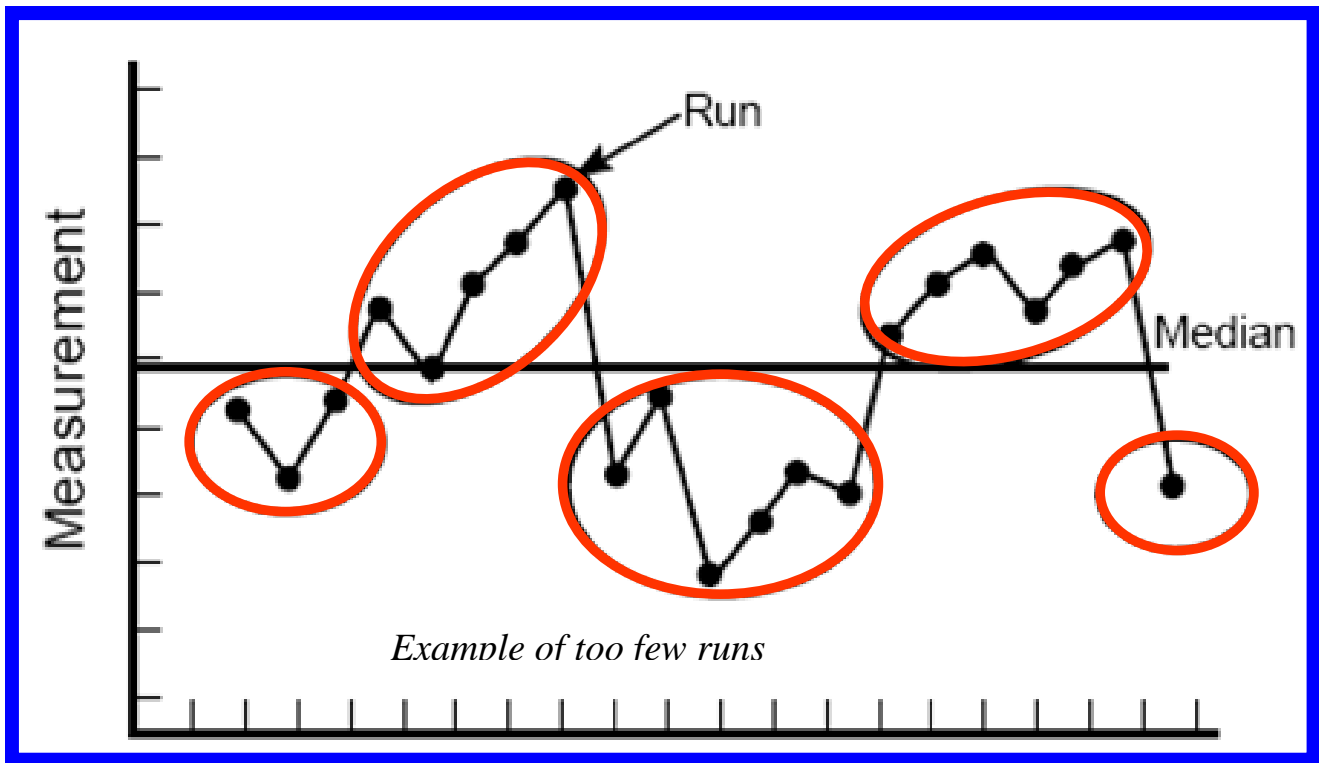
Some special cause variation reveals itself in unusual run-chart patterns. These clues can direct you in your search for causes. Count the number of runs. Runs are sequences of points that stay on one side of, either above or below, the median line. One way of counting the runs is to circle these sequences and tally them. Another way of doing this is to count the number of times the run-line crosses the median, and then add one.

Compare the number of runs you count to the accompanying chart.

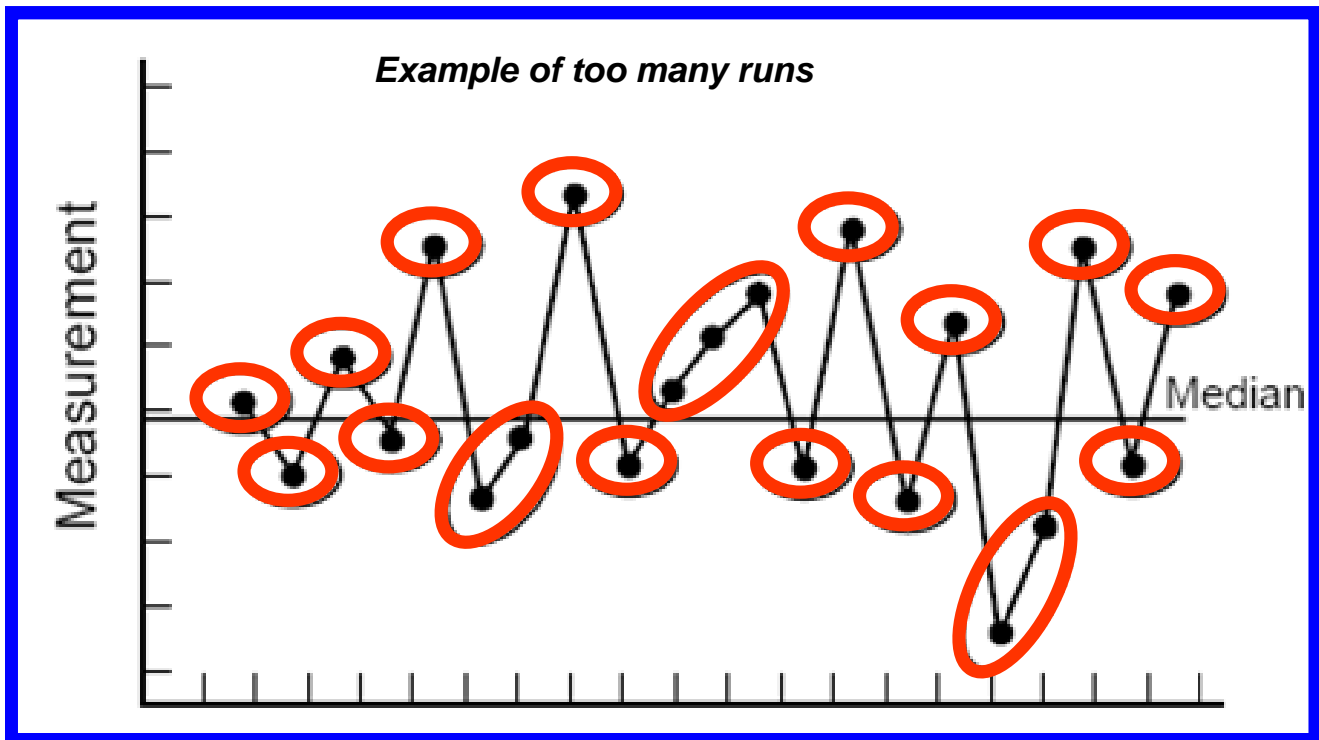
Numbers of runs outside the range shown for the number of data points are statistically unusual.

Number of data points	Lower limit for number of runs	Upper limit for number of runs	Number of data points	Lower limit for number of runs	Upper limit for number of runs
10	3	8	35	13	23
11	3	9	36	13	24
12	3	10	37	13	25
13	4	10	38	14	25
14	4	11	39	14	26
15	4	12	40	15	26
16	5	12	41	16	26
17	5	13	42	16	27
18	6	13	43	17	27
19	6	14	44	17	28
20	6	15	45	17	29
21	7	15	46	17	30
22	7	16	47	18	30
23	8	16	48	18	31
24	8	17	49	19	31
25	9	17	50	19	32
26	9	18	60	24	37
27	9	19	70	28	43
28	10	19	80	33	48
29	10	20	90	37	54
30	11	20	100	42	59
31	11	21	110	46	65
32	11	22	120	51	70
33	11	22			
34	12	23			

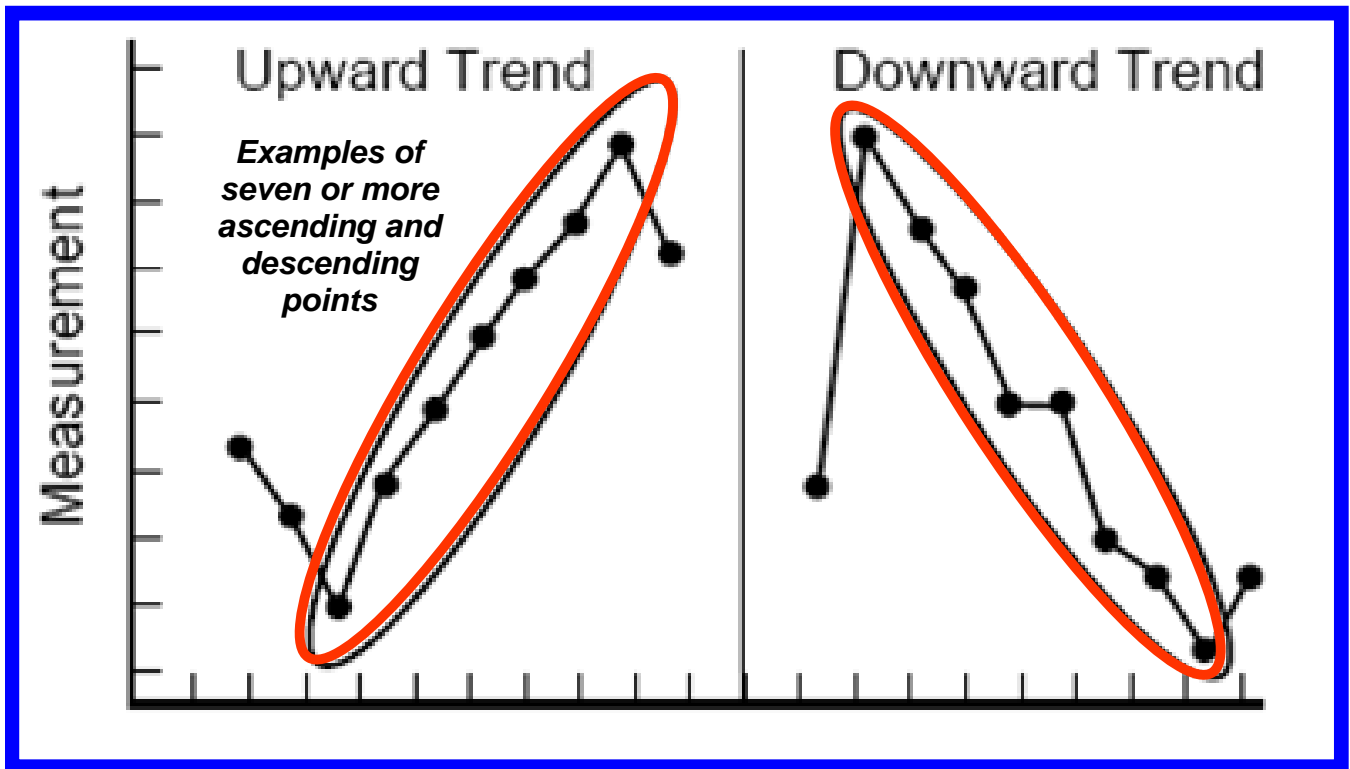
Too few runs (below the lower limit) generally indicate that something cyclic is systematically shifting the process average.



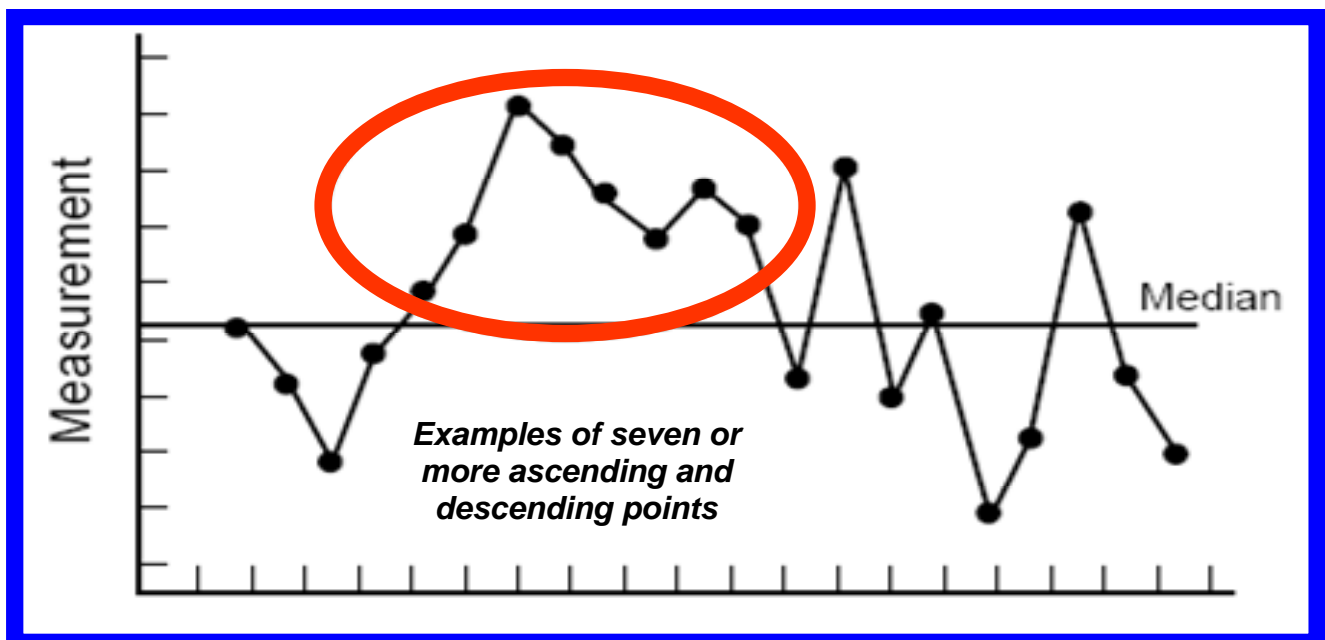
Too many runs could point to a problem of consecutive, over-compensating process adjustments or indicate that the data points actually came from two sources with different process averages.



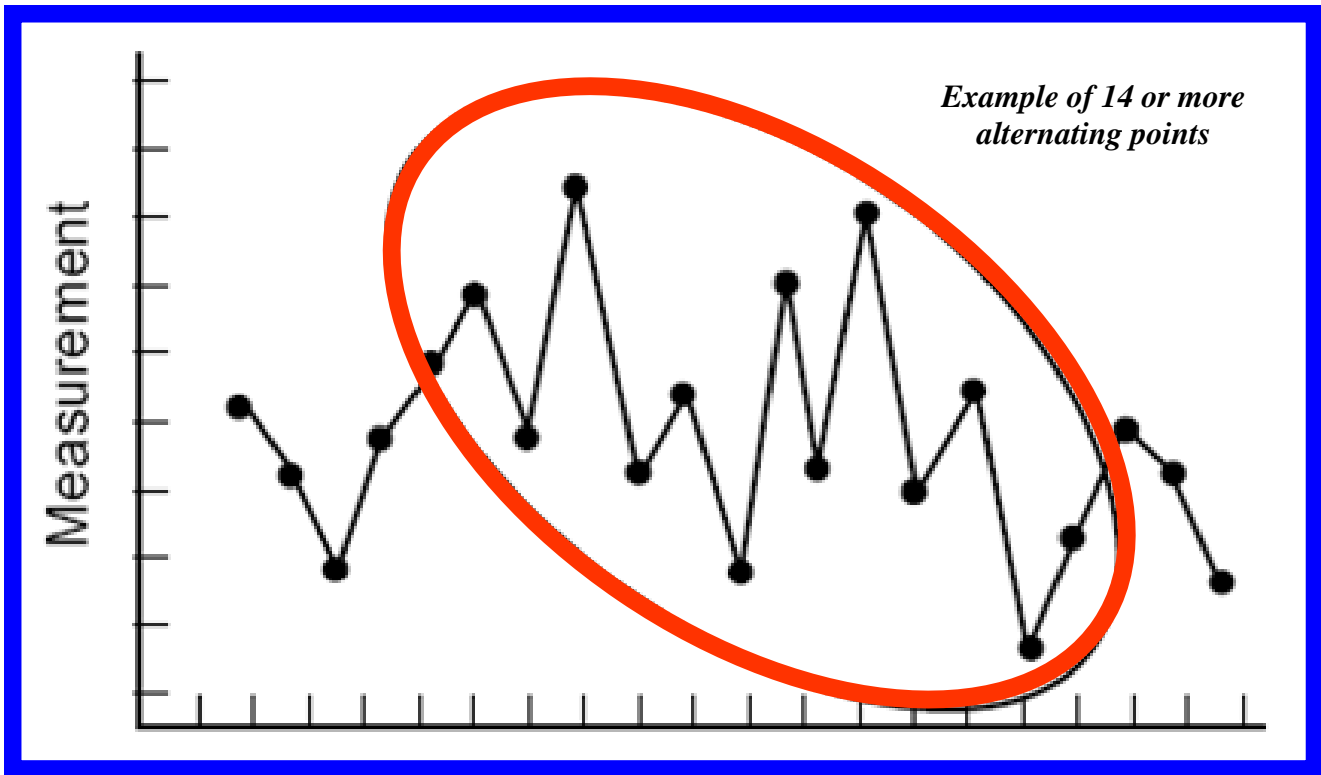
Look for sequences of ascending or descending values. Seven or more continuously increasing or continuously decreasing points indicates a trend that is shifting the process average. When you are counting points, ignore any points that repeat the previous value. Repeated values neither add to the length of the run nor break it.



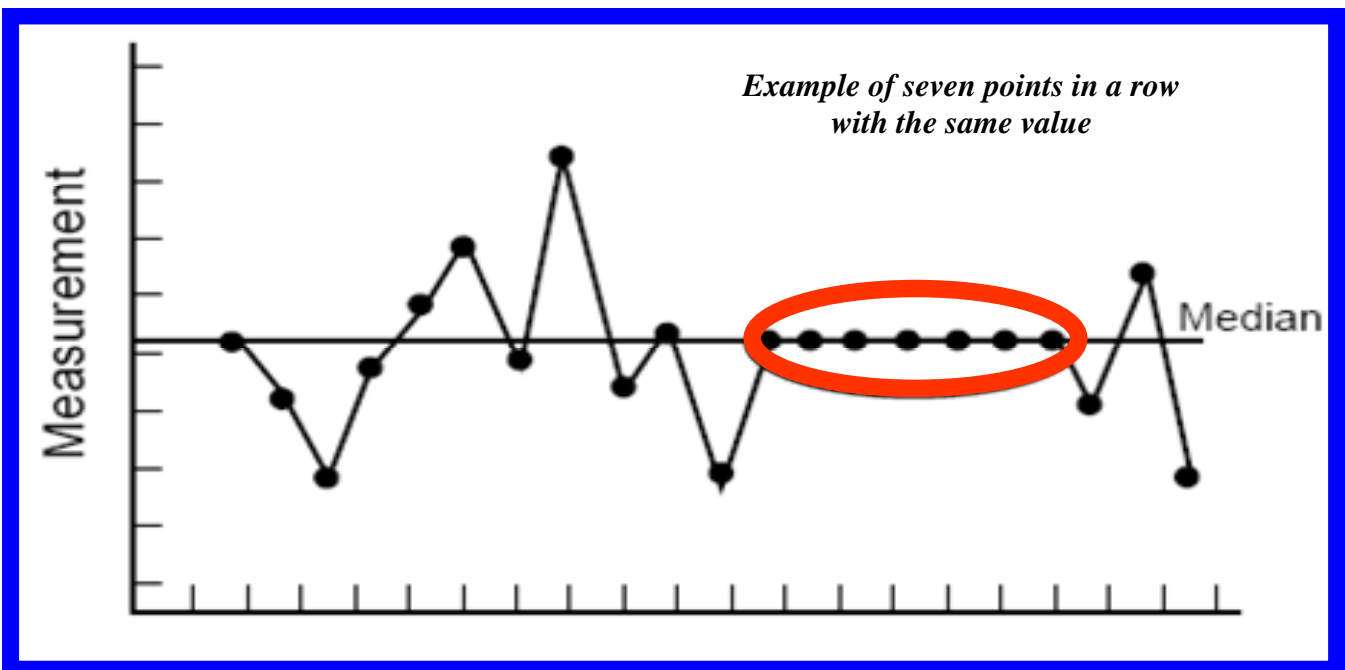
Search for seven or more consecutive points on the same side of the median line or 10 of 11 points or 12 of 14 or 16 of 20. (Ignore any points that are exactly on the median.) Such a sequence indicates that something has occurred to shift the process average in that direction.



A sequence of 14 or more data points alternating up and down suggests a variation related to sampling (such as one reading early in the day and one reading toward the end) or that the data is coming from two sources with different process averages (such as from two machines making the same part.) In looking for up-and-down alternation, ignore any points that are exactly the same as the preceding point.



A sequence of seven or more points with exactly the same value usually should signal you to look for a special cause. While it is possible that your process has improved to the extent that the existing measurement technique is no longer sensitive enough to measure variation, it is usually more probable that a gauge is stuck or broken or that someone is making up the data.

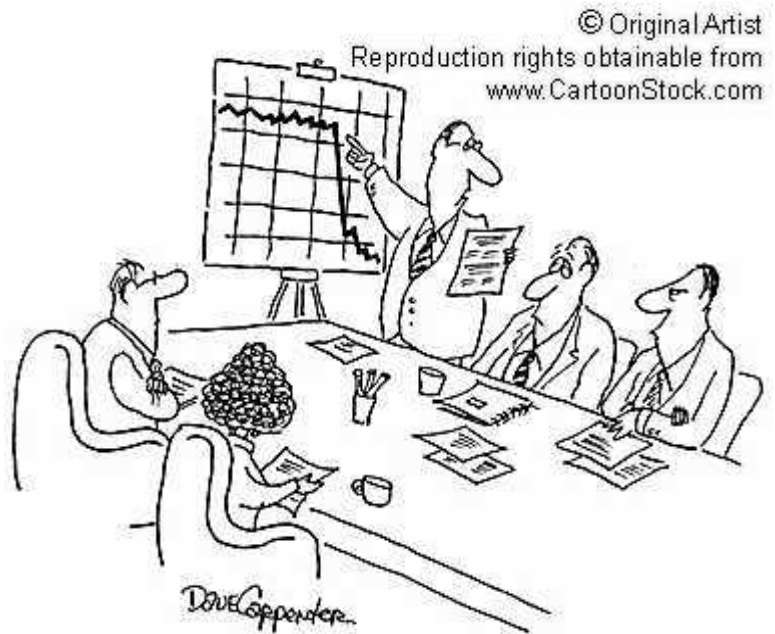


## Now what?

Run charts can be very valuable in helping your search for sources of variation. They are easy to plot and easy to interpret. The sampling is uncomplicated, and there are no statistical computations to make. They can also be applied to almost any process or any data.

On the other hand, they are not an instant indicator. They are best used for spotting trends; short shifts in the process cannot always be detected with run charts. In addition, special causes that produce general piece-to-piece variation will not be readily detected on run charts.

Finally, a simple run chart cannot establish the natural capabilities of a process, so it isn't possible to use one to predict what specifications a process can actually meet. To do that, you need to create a control chart, a run chart with statistical control limits.



"It was here when Harris decided to 'tweak' things a bit..."



Steven Bonacorsi is a Certified Lean Six Sigma Senior Master Black Belt instructor and coach. Steven Bonacorsi has trained hundreds of Master Black Belts, Black Belts, Green Belts, and Project Sponsors and Executive Leaders in Lean Six Sigma DMAIC and Design for Lean Six Sigma process improvement methodologies. He has led some of the largest deployments in the world and has saved hundreds of millions with his project teams results.

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