What Does SPC Really Do?

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Statistical Process Control (SPC) suffers from a misleading name. It is not, and can not be, used to *control* anything.

SPC is designed to do only one thing. It can tell you if a process is not operating consistently over time because it is being disturbed by external influences. The external influences can be such things as operator adjustments, raw material inconsistencies, fluctuations in utilities (power line voltage, water pressure, compressed air pressure, etc.) and the like. If the process is being disturbed, SPC can usually tell you approximately when the process changes occurred.

That's it. But that's enough to make SPC a very valuable tool for process improvement.

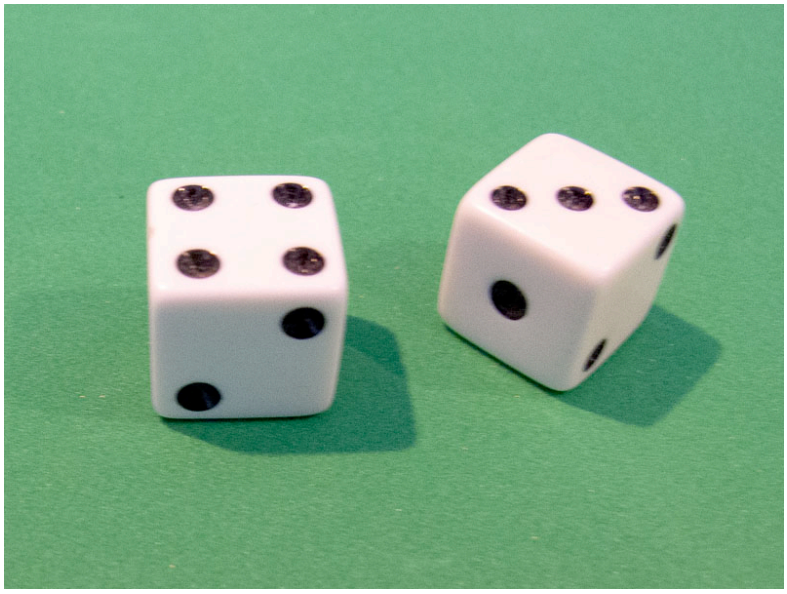
Now you're saying, "Wait, do you think I wouldn't know if my process were being disturbed like that?" Well, maybe, but probably not.

That's because all processes are subject to variation. They don't always produce the same results, even if we do everything as nearly as possible the same way every time.

And in fact, processes can be subject to two kinds of variation:

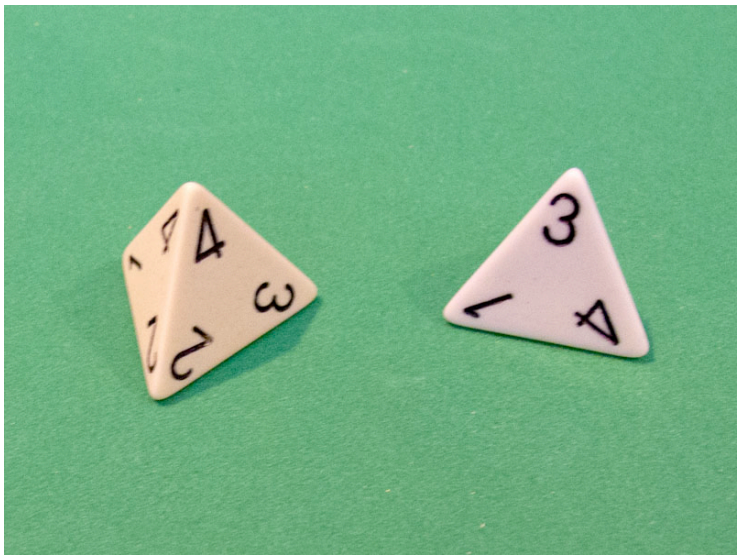
> "natural" or internal variation, also called "common cause" variation, that is always present; and
>
> "disturbance" or external variation, also called "special cause" or "assignable cause" variation, that comes and goes over time.

To make this easy to understand, let's consider a familiar "process" with a variable output.



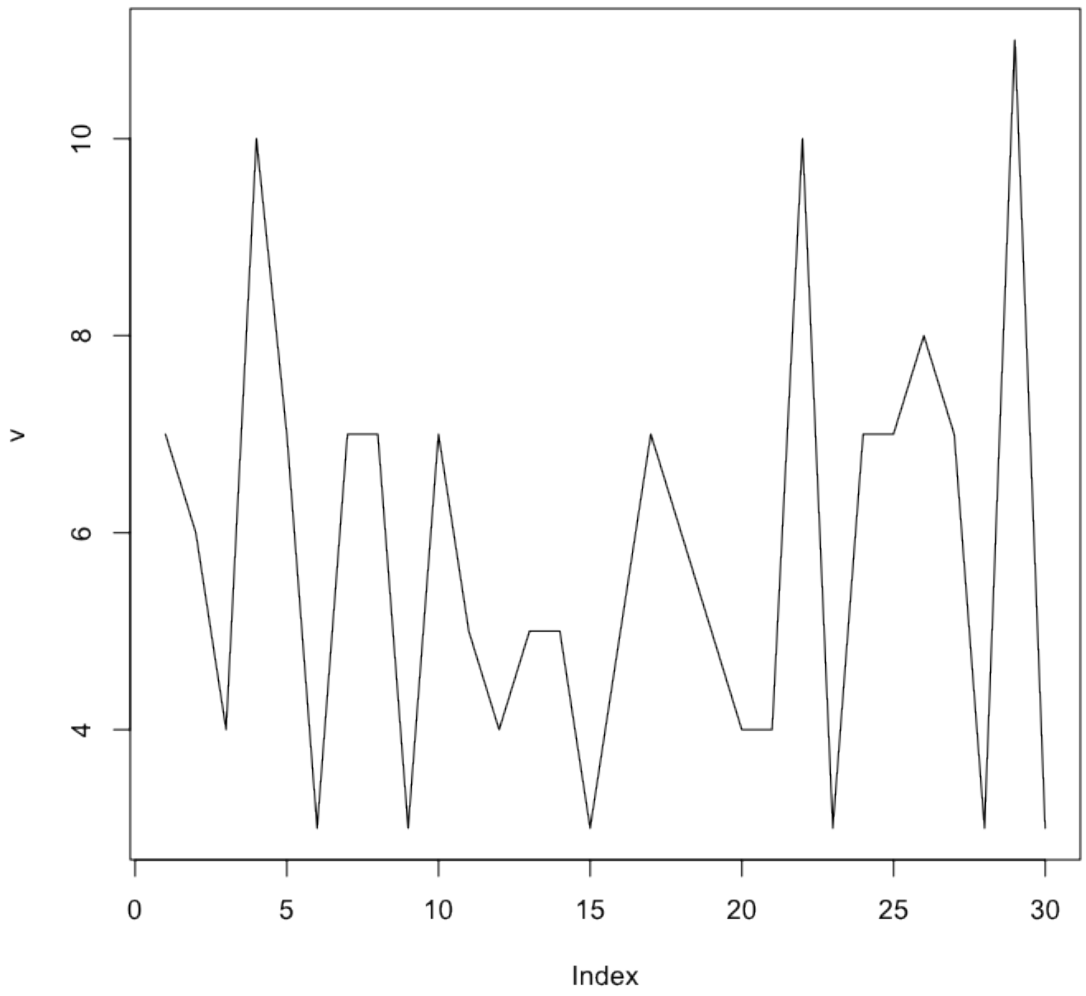
With each “operation”, this process produces an output that is a number between two and twelve. But it is unpredictable, except in general terms. Over a long period, the number seven should occur most frequently, with less frequent occurrences as the values get further from seven. But we can’t say with certainty what the next value will be. Let this be our process with “natural” variation.

But what if the process were subject to a disturbance that sometimes substituted this process?



Hmmm. The outputs will still technically be numbers between two and twelve, but actually will be between two and eight. The most frequently occurring value will now be five.

Surely one would notice such a drastic change, right? Well, let’s give it a try. Here’s a plot. See if you can tell if a switch was made, and if so, when?



Since you already know the undisturbed process produces values greater than eight while the disturbed process does not, you know that points 4, 22, and 29 come from the undisturbed process. What about the other points? You can't really tell.

You might take a guess that points 6 through 21 came from the disturbed process. That would be possible, but wrong. Actually, points 11 through 20 are from the disturbed process and points 1 through 10 and 21 through 30 are from the undisturbed process.

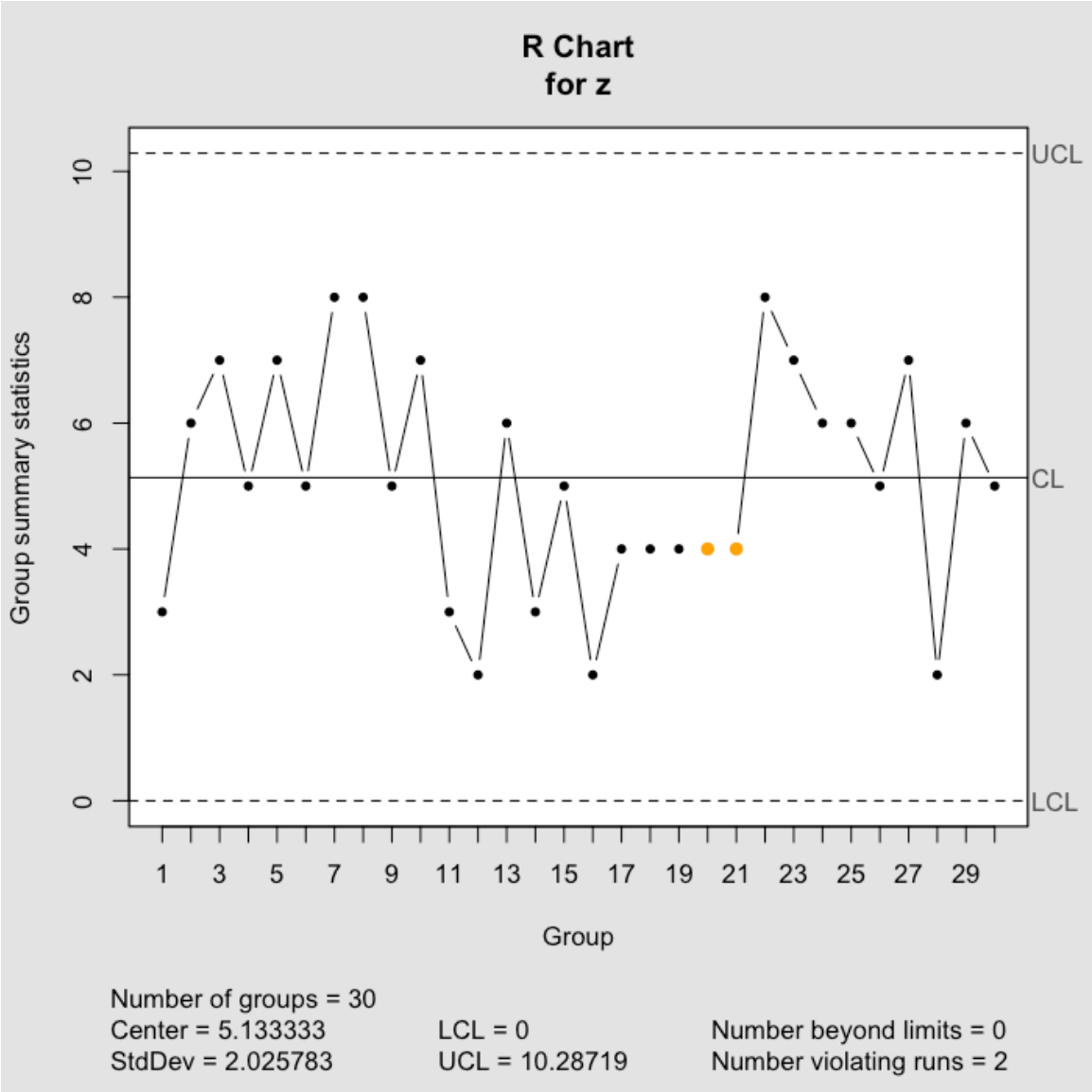
So how about SPC? How would it help?

Let's look at the process using a pair of complementary control charts, the X-bar chart and the R chart. Data is collected and plotted over a period of time where the first third of the data comes from the undisturbed process, the middle third from the disturbed process,

and the final third from the undisturbed process. Each point represents six consecutive rolls of a pair of dice.

We won't go into how to construct the control charts, or how they work, just what they tell us. Note that the analysis is not complete unless we look at both the X-bar and R charts.

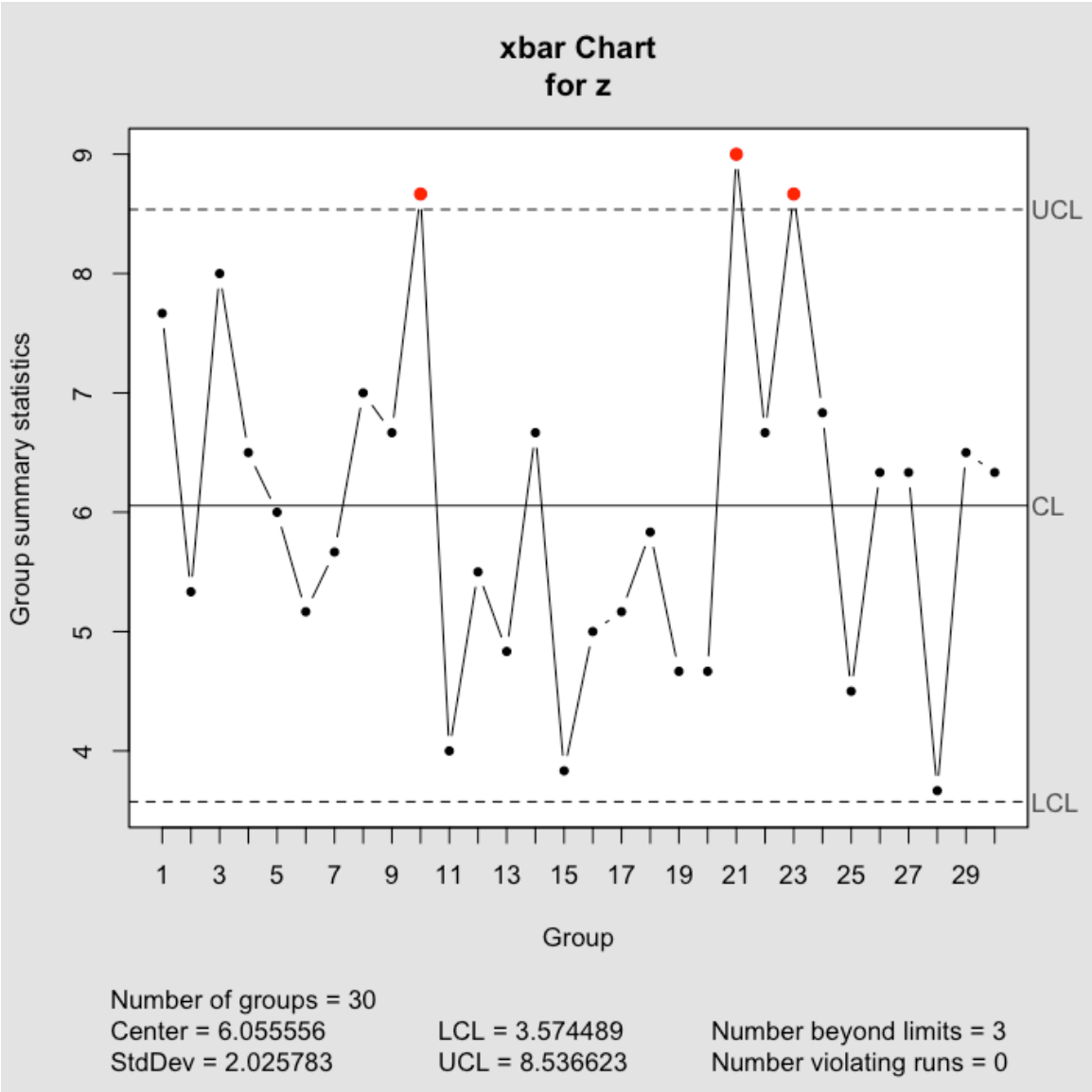
This is the R chart.



The important things to note are the two orange-yellow points. These are warning signals indicating a problem has been detected. We also see the caption at the bottom right saying "Number of violating runs = 2". The SPC charting software has flagged point 20 as the point at which seven consecutive points have been below the center line. This is an

indication of a change in the process that began approximately seven samples ago. The subsequent point is also yellow-orange, indicating that the trend has continued.

And this is the X-bar chart.



Note here that points 10, 21 and 23 are shown in red. This indicates that the values are above the upper control limit, the dotted line across the top of the chart. The comment "Number beyond limits = 3" appears in the legend.

Looking at the chart, we see that the points 1 through 10 are relatively higher than points 11 through 20.

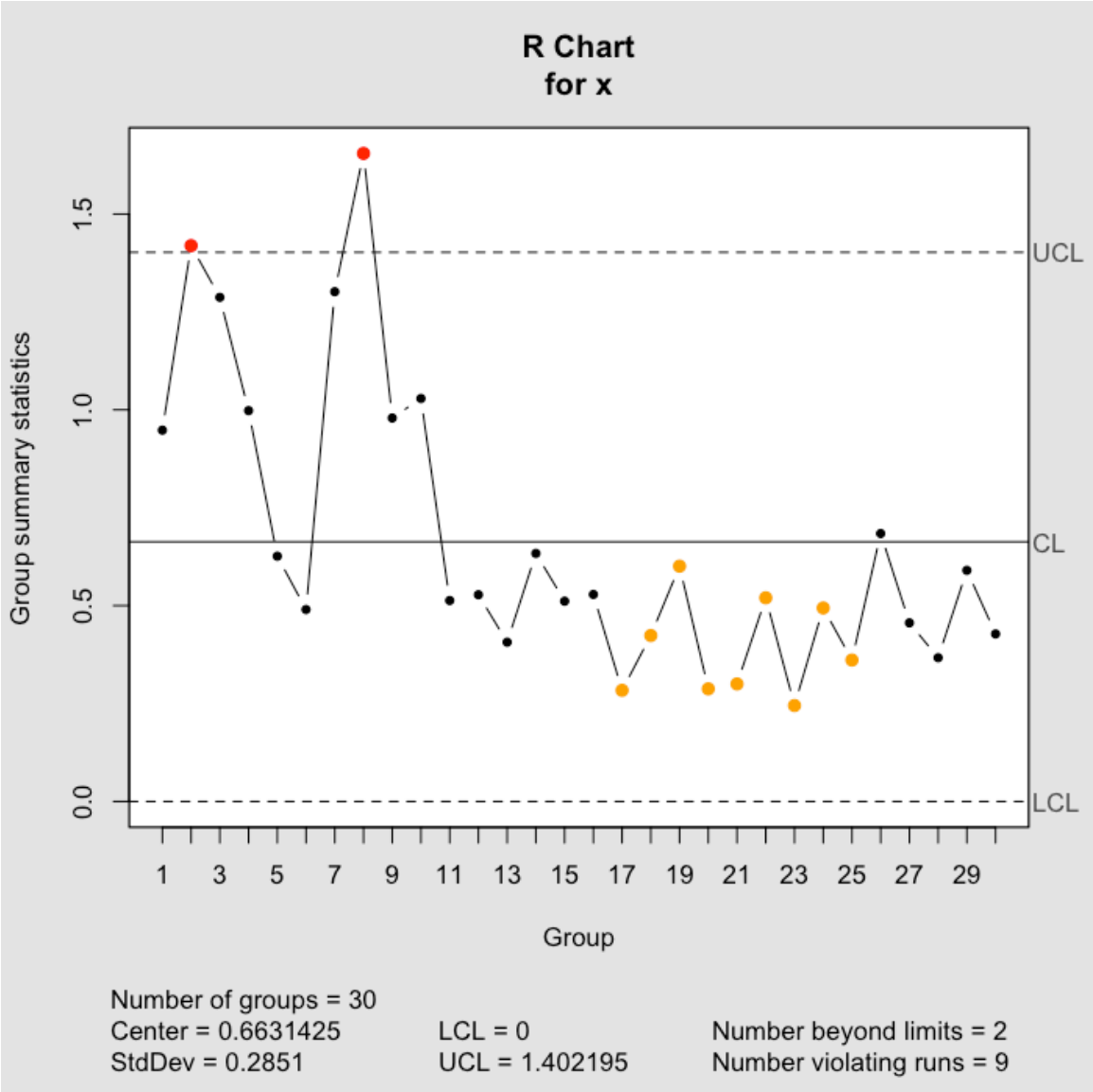
What we have learned from the two charts is that 1.) the process is probably being disturbed, and 2.) the period from point 1 through point 10 is probably different from the

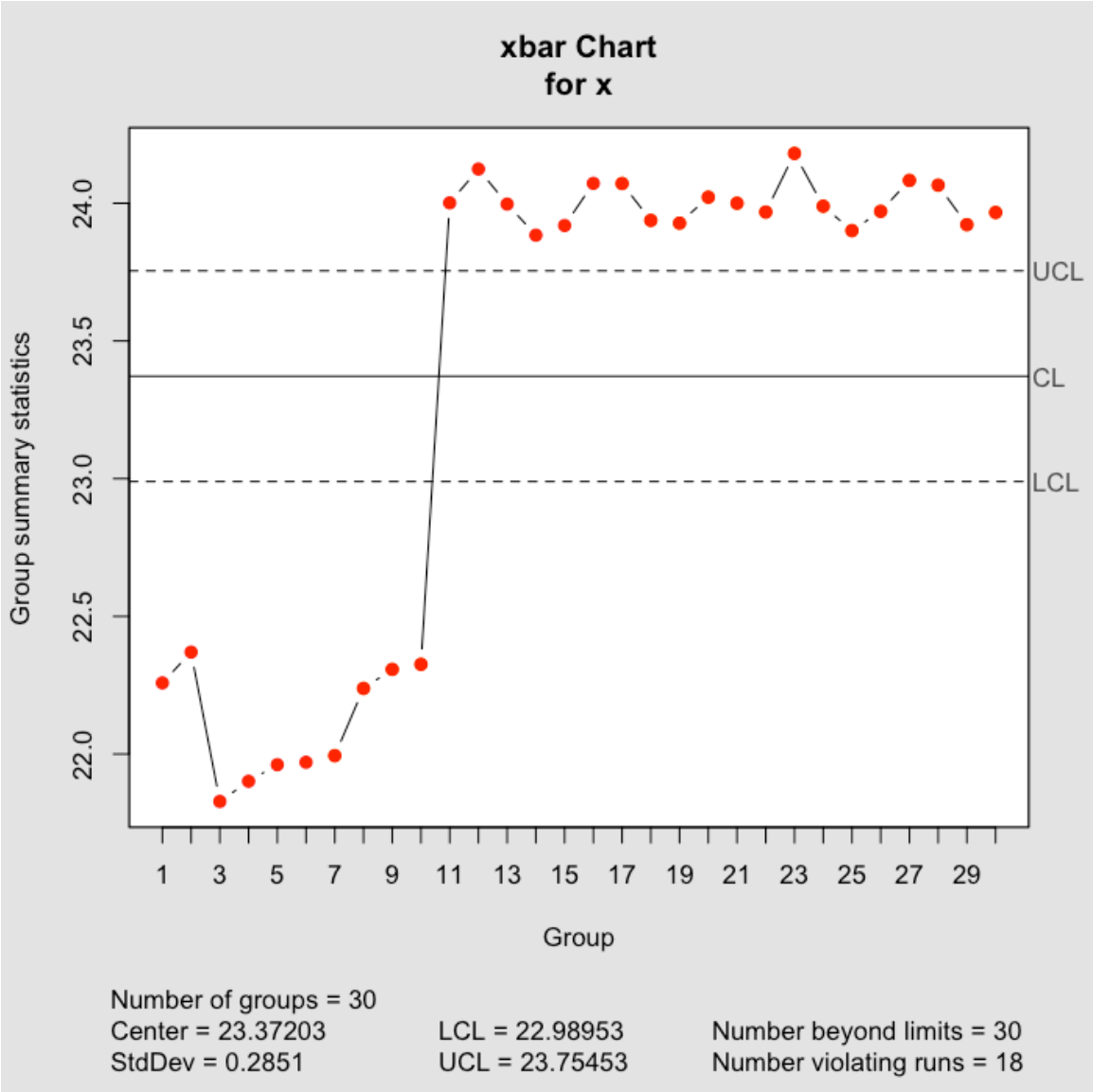
period from point 11 through point 20. What is less clear is that points 21 through 30 is more like 1 through 10 than 11 through 20.

But that's it. SPC has told us the process is being disturbed. Between the X-bar and the R charts, we suspect that one change occurred around point 10 or 11 and another around point 20 or 21.

Now what? We have to start investigating the process to see what was going on when the SPC chart indicated a potential problem. When we find a disturbance, or a suspected disturbance, we fix it. We also continue to plot data on our SPC charts. When the SPC chart indicates a problem may have occurred, we look for anything that may have changed.

Actually, this process disturbance example is fairly subtle and difficult to detect, even with control charts. Usually, the indicators given by the SPC charts will be more definitive, like these examples.


R Chart
for x
Group summary statistics
0.0
0.5
1.0
1.5
UCL
CL
LCL
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
Group
Number of groups = 30
Center = 0.6631425
StdDev = 0.2851
LCL = 0
UCL = 1.402195
Number beyond limits = 2
Number violating runs = 9



And while source of the disturbances can be subtle and hard to find, they can often be glaringly obvious. The most common type of disturbance is an adjustment made by an operator who thinks she is improving things. Simply asking the people running the process not to make changes can often improve things dramatically.

(If you wonder how this can be, search the internet for the "funnel experiment".)