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Data precision - Do you have enough?

Donald Holmes

A. Erhan Mergen

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For Quality Control and Process Improvement Professionals

Should You Use Acceptance or Modified Control Charts?

There are some processes which, due to their nature, are expected to have unavoidable shifts in their average value but which are still able to satisfy customer established specifications. This situation occurs when the standard deviation of the process, at the various average values of the process, is very small relative to the tolerance width. In usual statistical process control terms, such a process is not in-control but may be able to produce an acceptable product. Charts that are useful for this type of situation are described in both Duncan (1) and Montgomery (2). You will need to look for "acceptance control charts" or "modified control charts" in those texts. We will show you how to build one in the next QC Report. But first we need to warn you that there is needless confusion about what the charts should be called.

It will appear as you read this literature that there are three different charts being generated for this situation. That is incorrect. There is one type:

- a chart which allows you to detect, using Xbars for example, when the process will be producing an unacceptable level of nonconforming products.

Confusing factor #1

This type of chart should be called an "acceptance chart" - not an "acceptance control chart" - since it deals only with the decision as to whether or not the process should be accepted or rejected. So, when you are reading about these charts in the texts mentioned, just ignore the word "control".

Confusing factor #2

The construction of acceptance charts requires that you decide what type risk you would like to consider (AQL, RQL, or a combination of AQL and RQL) when setting up the limits. If you decide to use an AQL type of risk setting, the chart will be referred to by some folks as a "modified control chart" and by others as just an "acceptance control chart" - but don't forget to drop the word "control" when you are explaining this to someone else.

In This Issue:

We also recommend dropping the term "modified" since it implies something other than acceptance may be going on here. (Duncan uses "acceptance"; Montgomery uses "modified") Everyone seems to agree that charts using RQL or combination RQL-AQL to establish risk levels should carry the word "acceptance" as a part of their title. Please forget "modified" - it just adds to the confusion.

There are really two different issues: acceptance and control. These two issues are independent of each other. However, if your process is "in-control", we certainly do hope it is also meeting specs. Don't be confused!

**Follow up article in next QC Report*

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PaperMill

Shift Forman	Customer		Grade/Caliper	Date/Time
Name	Name	PO	Grade	Date
Bob	Mill Corporation	35212	300C	1/14/00
Joe	ABC Milling	120899	200C	12/8/99
Joe	ABC Milling	120899	200C	12/8/99
Joe	ABC Milling	120899	200C	12/8/99
Tom	Mill Corporation	32111	300C	12/7/99

Basis Weight [gsm]					Caliper [um]
Max: 420.00 Nom: 400.00 Min: 380.00	Max: 420.00 Nom: 400.00 Min: 380.00	Max: 420.00 Nom: 400.00 Min: 380.00	Max: 420.00 Nom: 400.00 Min: 380.00		Max: 525.0 Nom: 500.0 Min: 475.0
Read 1	Read 2	Read 3	Read 4	Average	Read 1
400	401	402	401	401.00	500
402.00	402.00	402.00	402.00	402.00	502.00
405.00	405.00	405.00	405.00	405.00	505.00
400.00	400.00	400.00	400.00	400.00	500.00
400.00	400.00	400.00	400.00	400.00	500.00

Moisture [%]					Topliner Appea
Max: 7.5 Nom: 6.0 Min: 4.5	Max: 7.5 Nom: 6.0 Min: 4.5	Max: 7.5 Nom: 6.0 Min: 4.5	Max: 7.5 Nom: 6.0 Min: 4.5		Max: 5.0 Nom: 3.5 Min: 3.0
Read 1	Read 2	Read 3	Read 4	Average	Dirt
6.1	6.1	7.6	7.5	6.8	3.6
6.3	6.3	6.3	6.3	6.3	3.6
6.1	6.1	6.1	6.1	6.1	3.7
6.0	6.0	6.0	6.0	6.0	3.5
6.2	6.0	6.0	6.0	6.1	3.6

Data Discussion...

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Now that you're sure you have good data going into the database, the next issue is putting that data to work for process improvement. Suppose, for example, that you would like to improve the daily yield of your process. You "mine" the database to get the daily yield for the last three months. This data can then be presented as a histogram and/or a trend chart to help assess the situation. Having computer SPC software, like Custom/QC, will make that task rather simple to perform. And, having the SPC software embedded in the database, as it is in the QMDS, makes the whole task even simpler.

Suppose, next, you would like to determine the process factors that seem to be driving the yield to its various levels. Here again, SPC analyses, like multiple regression or key variable identification can help with the improvement task.

"You can't expect to have quality improvement without a measurement and analysis system."

Proper use of SPC is one of the most important steps in a good process/quality improvement program. "You can't expect to have quality improvement without a measurement and analysis system", said Jim Poirier, CQE. "Many companies out there that are 'doing SPC' cannot identify any return on their SPC investment because they are simply drawing control charts. They are not hunting for 'assignable causes' and making improvements. Management and shop-floor personnel need to understand and utilize the tools of SPC."

What makes the Stochos system unique is that the QMDS puts the data, the necessary analysis tools and process information into the hands of both management and shop-floor operators. It is imperative that training in the use of the QMDS and the proper analysis procedures be accomplished. Otherwise, the collection of data is an exercise in futility. If you don't use it (the data), you might as well not collect it.

Dr. W. Edwards Deming insisted that the discovery of a special cause of variation and its removal should be the responsibility of someone connected directly with the operation that yields data for the control chart. This also points out the necessity for both management and shop-floor personnel to have a solid understanding of the basic philosophy of SPC - of the essential nature of process variation.

Stochos has provided basic and advanced SPC training to leading U.S. and foreign companies for its entire 30 years of existence. This training in proper measurement techniques, data mining and analysis provides a very strong basis for process improvement.

Important News for Stochos Customers

SUPPORT ON THE WEB

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Data Precision - Do you have enough?

By Donald Holmes and Erhan Mergen

The control chart on page 4, gives a clear signal that the data has a problem with precision. There are only four or five "plateaus" in the data. This would occur, for example, if you were measuring thickness with a ruler calibrated in units of 1/16 ths and there was little chance for variation in the data. The data is not being measured and/or recorded to a sufficient number of digits to be helpful for quality improvement efforts. It is almost like using "attribute" data with four classes rather than the usual two classes that occur in p charts.

The standard rule that one often hears is that the space between the "tick marks" on a gage should be small enough that the specification limits will be at least ten tick marks apart. We suspect that this rule is but another result of the fact that we have

Cont'd on Page 4

FUTURE EVENTS

Oct. 25 & 26, 1999
Dec. 6 & 7, 1999
Process Improvement Seminar
Achieving Model-Free Process Optimization through On-line Experimentation
Hampton Inn Detroit Metro Airport
Romulus, MI
8:30 - 4:30, Studio Rm # 211
(734) 721-1100

Nov. 15 & 16, 1999
Jan. 24 & 25, 2000
Process Improvement Seminar
Achieving Model-Free Process Optimization through On-line Experimentation
Hampton Inn - Airport
Pittsburgh, PA
8:30 - 4:30, Meeting Rm #121
(412) 264-0020

June 13 - 15, 2000
IMS Expo 2000
Cleveland Convention Center
Cleveland, OH

July 17 - 19, 2000
Unique SPC Workshop
Statistical Analysis of Operations Data
Held at:
The Center for Professional Advancement
East Brunswick, NJ
To Register Contact: CPA (732) 238-1600

Stochos... ***Achieving Model-Free Process Optimization through On-line Experimentation***
Process Improvement Seminar description: This seminar will deal with process improvements that may be accomplished by coupling integrated factory floor data collection (PCS and LIMS) with on-line, intelligent, model-free statistical experimentation and analysis. The concepts will first be explained in terms of a real plant example. The seminar will then address in more detail the required components of one such system.

Stochos offers on-site Process Improvement classes.
Contact: Konnie Steele for details.
Phone: (518)372-5426 or **Email:** Kesteele@Stochos.com

Data Precision...

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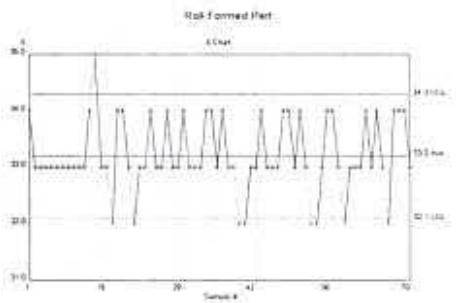
ten fingers. If we had 13 fingers, the rule would probably be at least 13 tick marks. So, in any event, we set out to see if there was some sort of rational basis for making this decision.

Our decision is based on an information theory argument. (You may refer to our Quality Engineering (QE 4(1), 1-7 (1991-1992)) article for a more detailed discussion of this matter.) We plotted the change in information available versus the number of tick marks available. From the plot, we selected the point at which the increase in information available as a result of using more tick marks seemed to be insignificant.

The result of this analysis was that the distance between the tick marks should be at about 0.3 times the standard deviation of the data or less. This would mean that if you had a Normal curve (approximately six standard deviations wide) that fit exactly inside the specification limits, then there should be about 18 tick marks within the specification limits. This is a large difference from the rule of 10.

Example: The data shown on the following Control Chart represents the width dimension of a roll formed part. The specifications were given as 35+/-3. The average and standard deviation for the data set of points were 33.2 and 0.6 respectively. This information indicates that the process is not properly centered but does have the ability to meet specs were it to be centered. Notice, however, the difficulty in trying to assess trends or unusual events early enough to be helpful.



The data used to make the chart is recorded to the nearest whole integer. The minimum value is 32. The maximum value is 35. The tolerance width for the product is (given 35+/-3 as specs) 6. Thus, the rule of ten tick marks inside the specs would indicate that the data should be measured and recorded to the nearest half unit (6/10 is approximately 0.5) rather than the nearest whole unit.

The rule we have developed would suggest that the data should be measured and recorded to the nearest quarter (0.3*0.6 is approximately 0.25) of a unit. Or perhaps, if possible, the tick marks should be in 0.2 of a unit.

Note that the average and standard deviation of the data recorded to the nearest integer are recorded to the first decimal point. This is appropriate since the precision of averages and standard deviations is greater than the precision of the individual measurements. This statement is based on the following facts about sampling distributions:

- The standard deviation of sample averages is the standard deviation of the individual data points divided by the square root of the size of the sample used to calculate the average, and

- The standard deviation of the sample standard deviations is approximately the standard deviation of the individual data points divided by the square root of twice the size of the sample used to calculate the standard deviation.

Thus, for a reasonable sample size, the average and standard deviation should be recorded to at least one more digit than the original data. For control charts using small samples (4 or 5) it is standard practice to follow the procedure of one additional digit of precision.