Theory

What is the difference between the stability and the capability? Is it possible that a process is stable but not capable?

When should and when shouldn't we use control charts?

What is the difference between the phase I and phase II study when using control charts?

When do we commit an error of first kind when using control charts?

When do we commit an error of second kind when using control charts?

What do we check with the control charts?

Why do we use the variables control charts in pairs (i.e. X bar - R, individual - MR)? When is it enough to use one chart only?

What are the Western-Electric rules are used for?

When only individual values are known (the sample size is 1), how do we get any information about the variance?

What is the difference between the control- and the specification limit? Based on what are they calculated and what are they used for?

Is it necessary for the control limits to be between the specification limits? Why?

What is the relative position of the control limits of the individual value and the x bar chart?

What is the connection between the observable process shift (with control charts) and the sample size?

How could we improve the sensitivity of the Individual value chart?

What can be a moving range chart used for?

How large is the ratio of noncomforming parts if C_P=1. Sure?

Could C_P and C_{Pm} be the same?

Could C_P be lower than C_{Pk}?

What is the relation between C_{Pk} and C_{Pm}?

Could C_P be less than C_{Pk}?

What is the difference between C_P and P_P?

Which capability indices are sensitive to the magnitude of process variance?

Which capability indices are sensitive to the magnitude of process shift (the difference between the target value and the expected value)?

What is the connection between the capability indices and the ration of noncomforming parts?

Why is it important to have a process with good capability? Isn't it enough not to have any nonconforming parts in the sample?

If C_P=2, where are the control limits located compared to the specification limits?

How should we perform a measurement system analysis?

Is it possible to do a Gage R&R analysis, if the process specifications are not known?

What should be done if the variance of the reproducibility is large?

As a result of attribute measurement system analysis you observe that $\sigma^2_{R\&R} >> \sigma^2_{part}$. What is the conclusion?

Calculation

1. The volume of an ampoule should be 5.00+/-0.05cm^3. The ampoule filling machine has a variance of 0.001 (cm^3)^2. The filling process is shifted, the expected value of the filling

volume is 5.02 cm^3. How many percent of the produced ampoules will be below/above the specifications?

2. The results of a measurement system analysis:

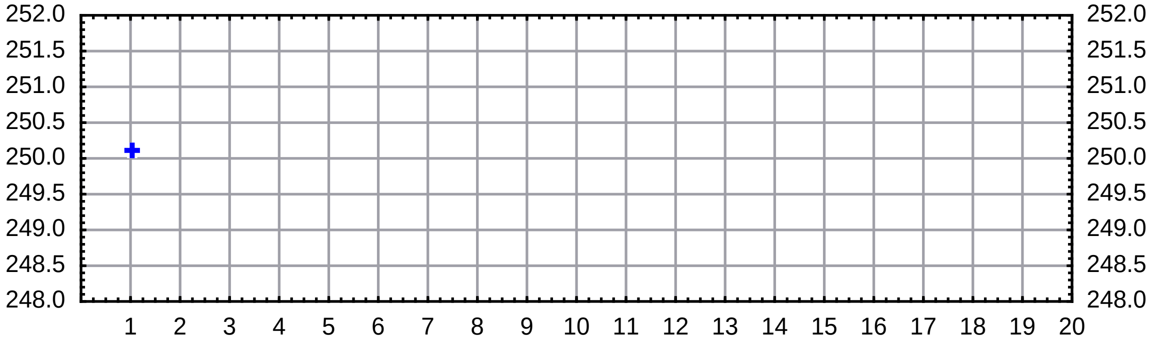
$\sigma_{part} = 1.4, \quad \sigma_{repeatability} = 0.2, \quad \sigma_{operator} = 0.4, \quad \sigma_{operator*part} = 0.03$

How large is the overall variance of the measurement system compared to the variance of the parts?

3. Design a double sampling plan for the inspection of a lot of size 25 000. The general inspection level is III and the allowed ratio of nonconforming parts in the lot is 0.004.

4. Samples of three elements were taken from a process, the results are given in the table.
a) Is it a phase I or Phase II study? (Why?)
b) What kind of chart (or charts) would you suggest to this process?
c) What will be the control limits of the chart (or charts)? Draw them on the charts and put there the first 10 points.
d) What do you think, is this process stable?
e) The overall **variance** of the data are: 0.89, the variance within samples is 0.817. The process specification is 251+/-3. Calculate the long term and the short term capability indices and comment the results.
f) How many percent of the products will be below/above the specification limits in long term?

sample	**measured sample items**			**mean**	**range**
1	249.7	250.2	250.2	250.0	0.6
2	249.8	251.0	249.5		
3	250.2	250.1	250.1	250.1	0.2
4	249.8	249.3	250.9	250.0	1.6
5	251.1	248.1	248.5	249.2	3.0
6	248.1	250.1	248.9	249.0	1.9
7	249.6	249.2	249.6	249.5	0.4
8	247.7	249.4	248.9	248.7	1.7
9	249.4	249.6	251.6	250.2	2.2
10	250.7	249.6	249.1	249.8	1.6
11	250.1	251.2	250.1	250.5	1.1
12	249.5	248.8	251.6	250.0	2.7
13	250.1	251.7	250.4	250.7	1.6
14	250.3	250.2	249.5	250.0	0.8
15	252.4	251.5	249.9	251.3	2.5
16	250.9	249.3	249.9	250.0	1.6
17	249.7	248.1	250.6	249.4	2.5
18	249.8	250.6	250.4	250.3	0.8
19	249.8	249.9	250.1	249.9	0.3
20	248.6	250.6	249.4	249.6	2.0
	mean			**249.9**	**1.5**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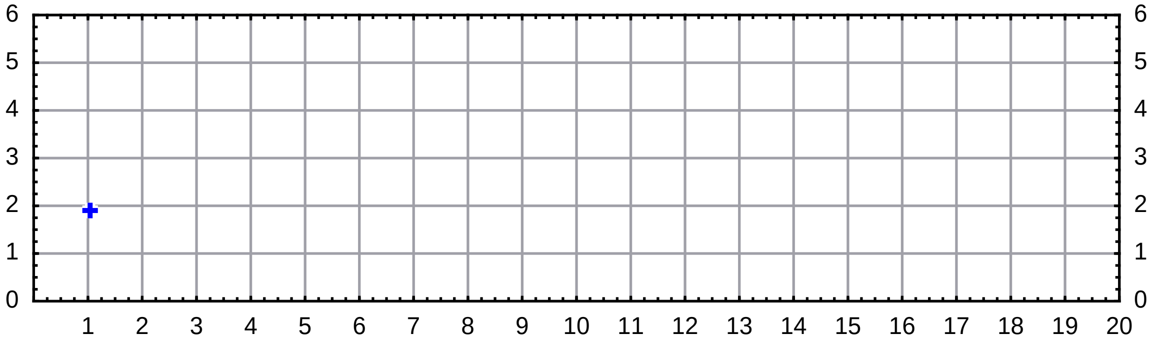
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