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2.830J / 6.780J / ESD.63J Control of Manufacturing Processes (SMA 6303)
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Massachusetts Institute of Technology
Department of Mechanical Engineering
2.830-6.780J / SMA 6303 Control of Manufacturing Processes
Quiz 1
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Open Book and Notes

Problem #1 (35%)

A tire company has developed a new tread design that is expected to have a mean life of 60,000 miles. To test this, a single sample of 9 tires is taken. We can assume that tire life is normally distributed, and from the 9 samples determine a standard deviation of $s = 1200$ miles and a sample mean of 60,578

- a) Based on the one sample mean, how confident are you that the mean of the process is 60,000?
- b) If instead, the hypothesized true mean was 59,000, how would your level of confidence change, given the same single sample mean?
- c) Suppose the true mean value was indeed 59,000 but we assumed it was 60,000. We then begin charting production with samples of size $n=4$ how long until we would it take until we realized that the grand mean was 59,000 and not 60,000?

Problem #2 (35%)

You have an assembly process that yields a final dimension that is to be controlled. The target value for this dimension is 100 mm, and the specifications call for a process capability $C_{pk} = 1$. However, you also note that the design specifications are not symmetric, but instead given by:

$$x = 100 + 2 / - 1$$

Thus USL = 102
and LSL = 99

- a) Process measurements show that for every 5000 parts produced you are seeing 15 parts out of specification. What would be the corresponding value for C_{pk} ? Please sketch this situation with a distribution, and superimposing the specifications given above.
- b) After charting the process for some time, the operator notices that the average value for the process is 100.5mm not the target of 100. After consulting with the local manufacturing engineer, they decide to re-center the process so that it is on target (i.e. 100mm), since that is what the specs call for. After running with this new mean for some time, they calculate the C_p and C_{pk} . What values would they get?

c) Now you come along and tell them to use the Quality Loss Function to best quantify this problem. Compare the expected quality loss for the above situation to what it would be if the limits were symmetric about a target of 100.5 mm.

(NB: you can assume that the cost of exceeding either the upper or lower specification limit is the same.)

Problem 3 (30%)

The process variance of the thickness of a CVD (Chemical Vapor Deposition) layer has historically been too high, and you have sought out a solution. A tool vendor comes up with a new wafer chuck and claims they can reduce the process variance from 10 to 4 \AA^2 . Having argued vociferously for the purchase of this tool, you are anxious to test it, but are told you can only do 5 runs with the new tool before regular production must start. Given this restriction you press on.

After performing your tests you determine a sample variance of 10 \AA^2 . Your boss then says: "well ... did it work?" You want there to be only a 5% chance that your answer is wrong, so you tell your boss _____!

In other words, can you claim to 95% confidence that the true process variance is 4 \AA^2 ?

(Hint: the advertised value of variance (4 \AA^2) can be considered a sample variance determined with a very very (very) large number of samples.)

Please explain all your steps in this solution.