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Strategic Sampling Outperforms Random Sampling

by John J. Flaig, Ph.D.

Traditional sampling theory as presented in Mil Std 105, 414, etc. has as an underlying premise that defects are randomly distributed throughout the population. However, an examination of many real world processes indicates that this assumption is frequently at odds with observed reality. Specifically, the distribution of special cause defects is frequently not random but clustered. The implication of this observation is that classical sampling techniques may not be optimal for dealing with clustered defect processes.

Hypothesis

Given that the process generates defects that have a consistent cluster pattern, a uniform sampling plan can be expected to outperform a random sampling plan. Further, even if the defects are randomly distributed, the uniform sampling plan performs just as well as the random sample plan.

Argument

Without loss of generality consider the following example. Given a lot size of one hundred (N = 100), a sample size of ten (n = 10), and ten defects in the lot

(d = 10). Further, assume that all ten defects are next to each other in the time series order of production. Using an acceptance number of zero (c = 0) sample plan and random sampling the probability of lot acceptance is Pa = .33 based on the hypergeometric probability distribution. However, Pa = 0 for the uniform sample plan (USP) with sampling frequency f = 1/10. The uniform plan will always catch a defect and reject the lot whereas the random sampling plan has only a 67% chance of rejecting the lot.

Now assume that the ten defects are randomly distributed throughout the lot, then both uniform and random sample plans will have the same statistical performance. So uniform sampling does not reduce the expected performance of the sampling plan.

Conclusion

The use of uniform sampling techniques such as continuous sample plan (CSP-1) performs just as well or better than random sampling irrespective of whether the defect distribution is random or clustered. The only caveat to this is that the clustering must remain consistent. Recognizing this limitation, it is possible to test for consistency and if the process fails the test, to return to random sampling. I call this process strategic sampling and it can yield significant improvements over the classical random sampling approach.

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