Chapter 5

Conclusions

Most capability research works appeared in the literatures had not considered gauge measurement errors. Gauge capability has significant effect on process capability measurement. An inaccurate measurement system can thwart the benefits of such endeavors resulting in poor quality. Analyzing process capability without considering gauge capability leads to unreliable decisions.

In our research, we assume that measurement errors exist, and we consider sampling errors in process capability analysis. We considered the performance of the indices C_P, C_{PK} and C_I with presence of gauge measurement errors. We investigated the accuracy of the estimator $\tilde{C}_P^Y$, $\hat{C}_{PK}^Y$ and $\tilde{C}_I^Y$ when the sample data is contaminated by random measurement errors.

We have derived the expected value, variance and pdf of $\tilde{C}_P^Y$, $\hat{C}_{PK}^Y$ and $\tilde{C}_I^Y$, and we obtain that the ratio $\gamma_1 = \text{MSE}(\tilde{C}_P^Y)/\text{MSE}(\tilde{C}_P)$, $\gamma_2 = \text{MSE}(\hat{C}_{PK}^Y)/\text{MSE}(\hat{C}_{PK})$ and $\gamma_4 = \text{MSE}(\tilde{C}_I^Y)/\text{MSE}(\tilde{C}_I)$ increase with large measurement errors. In Chapter 2, we use the confidence interval bounds in Pearn *et al.* [36] to estimate the true capability C_P by $\tilde{C}_P^Y$, we show that the confidence coefficient becomes decrease with measurement errors. In Chapter 3 and 4, when we use the lower confidence interval bounds in Pearn & Shu [39] and Pearn & Chen [35] to estimate the minimum capability, we find that a large measurement error results in significantly underestimating the true process capability.

If we use the critical values with no correction in Pearn *et al.* [36], Pearn & Lin [37] and Pearn & Shu [40] to test whether the process capability meets the requirement by the estimators, $\tilde{C}_P^Y$, $\hat{C}_{PK}^Y$ and $\tilde{C}_I^Y$, we show that the α-risk and the power of the test may decrease with a significant magnitude due to gauge measurement errors. Since the lower confidence bound of the process capability is severely underestimated, and the power becomes much weak, the producers cannot firmly state that their processes meet the capability requirement even if their processes are sufficiently capable. Good product units would be incorrectly rejected in this case. Unnecessary cost may accompany those incorrect decisions to the producers. Thus, we present modified confidence interval bounds and critical values for the cases that measurement errors are unavoidable. With the desired confidence coefficient, we can significantly reduce the magnitude of underestimation by our modified confidence bounds. To ensure that the α-risk is within the preset magnitude, we have improved a certain degree of power in statistical testing by our modified critical values.