# Production Quality Yield and Process Loss Indices

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## Abstract

Process yield is the most common criterion used in the manufacturing industry for measuring process performance. A more advanced measurement formula, called the quality yield index ($Y_q$), has been proposed to calculate the quality yield for arbitrary processes by taking customer loss into consideration. Quality yield penalizes yield for the variation of the product characteristics from its target, which presents a measure of the average product loss. In other words, quality yield is calculated as process yield minus process loss within the specifications. Process loss index $L_e$ is defined as the ratio of the expected quadratic loss to the square of half specification width. In the literature, only sample point estimate for $Y_q$ is investigated. The decision maker would be interested in a lower bound on $Y_q$ rather than just the sample point estimate. Most research in quality assurance literature has focus on cases in which the manufacturing tolerance is symmetric. However, asymmetric tolerances can also arise in situations where the tolerances are symmetric to begin with, but the process distribution is skewed or follows a non-normal distribution. Under asymmetric tolerances situation, using $Y_q$ and $L_e$ would be risky and probably the results obtained are misleading. This dissertation focus on obtaining lower bounds on $Y_q$ and extending $Y_q$ and $L_e$ to handle processes with asymmetric tolerances. The concrete contributions of this dissertation are threefold. The first is to propose two reliable approaches for measuring $Y_q$ by converting the estimated value into a lower confidence bound. One approach is for production processes with very low fraction of defectives under normality assumption. For arbitrary underlying distributions, we propose a bootstrap approach to obtain lower confidence bound on quality yield. The second is to generalize $Y_q$ and $L_e$ for asymmetric tolerances. The merit of the generalization is justified, and some statistical properties of the estimated generalization are investigated. The third is to investigate the statistical properties of these natural estimators for $Y_q$ and $L_e$. The results obtained in this dissertation are useful to the practitioners in choosing good estimators and making reliable decisions on judging process capability.

**Keywords:** Asymmetric tolerances; Bias; Bootstrap methods; Lower confidence bound; MLE; MSE; Process loss indices; Quality yield; UMVUE; Upper confidence limit.