ABSTRACT

Optimization of Process Improvement and

Inspection Location for Serial Manufacturing. (May 1993)

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In manufacturing environments, an issue of concern to quality and production managers is the cost of producing defect-free end products. The cost of producing an item which must be reprocessed after an error or defect is acquired is greater than that for a unit which incurs no defects during production. If a unit acquires a defect that goes undetected through subsequent processing steps, error propagation is said to occur. Since the cost of rework increases with the number of steps which must be repeated, the timely detection of errors is an important factor in reducing production costs. The probability of error propagation is reduced with inspection. Moreover, decreasing the probability of errors occurring decreases the likelihood of an item requiring rework.

Although several authors have acknowledged the sensitivity of production costs to defect rates, almost none have incorporated process improvement into their production cost minimization procedures. Furthermore, the expenses resulting from rework and error propagation have not been explored. Those who did consider rework as part of production costs assumed it to be a fixed model parameter and generally assumed

that units undergoing rework were restored to defect-free status. Thus, the impact of reprocessing on production costs has been simplified.

In this study, a procedure to determine the optimal combination of inspection and process improvement that minimizes the cost of processing, rework, inspection, and penalties for shipping defective items is developed for a serial manufacturing system with imperfect inspection procedures. It is assumed that all defective items can be reworked and inspectors may not identify all defective items. The movement of a unit through production processes is modelled as a Markov renewal process. Thus, the effects of rework are directly incorporated as state transitions. Within the framework of Markov analysis, an expression for the expected per unit total cost of production is developed. A nonlinear optimization procedure for determining the optimal process defect rates corresponding to each possible inspection station configuration is formulated. The solution procedure determines the minimum cost achievable for each inspection station configuration. Hence, the optimal mix of process improvement and inspection can be identified.