NEW RESULTS IN THE INTEGRATED ANALYSIS OF QUALITY AND QUANTITY IN PRODUCTION LINES

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Abstract

Manufacturing systems analysis is the field that develops methods for predicting and understanding the behavior and performance of manufacturing systems. Manufacturing systems engineering uses these methods and understanding to design efficient, effective factories.

Increased competition and product variety and decreased product lifetimes have generated great interest in productivity and quality issues. During the past three decades, the success of the Toyota Production System and other production system design methodologies have spurred much research in manufacturing systems engineering.

There is an extensive literature on quality, and on the strategies that emphasize quality. There is also much literature on quantity, and on the strategies that emphasize quantity. However, there is little literature that deals with both together, and little literature that considers quality in a systems context.

In this talk, we propose a new class of models that are intended to deal with this issue. They are similar in spirit to earlier quantity-oriented models, in that machines are modeled by Markov chains with discrete states. Here, however, the up states have quality information associated with them, e.g., the yield conditioned on the machine being in that state.

Using such models, we analyze how production system design, quality, and productivity are inter-related in production systems. We show how inventory capacity can influence system yield and productivity, sometimes in counter-intuitive ways.

A taxonomy is presented for issues related to quality failures, and a class of stochastic models is described to represent a realistic subset of those failures. Quality control mechanisms are formulated, including scrapping of defective parts as well as information feedback resulting in taking offending machines down for maintenance.
Pertinent performance measures are defined, including mean total production rate, good (i.e. not defective) production rate, yield, in-process inventory, and lead time.

A new decomposition technique is presented for performance evaluation for multiple-stage production lines. A new feature that appears when quality is considered is the location of inspection stations, and the set of machines that they observe. We describe the technique for a variety of different sets of inspection locations.

We describe simulation results including the investigation of the effect of the number and placement of inspection stations, of machine and buffer parameters, of inspection policies, of control policies (scrapping and information feedback), and of production line topology on selected performance measures.