The impact of production interruptions on kitting, an analytical study

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I. Introduction

Efficient transport of materials between stages of a production process is key in the minimization of production costs. The kitting process studied here is an attempt at achieving efficient transport and thus reducing costs. In kitting the necessary parts for assembly are collected into a specific container, a kit, prior to arriving at the assembly line [1]. This is in contrast to a system where parts arrive at the assembly line in containers of equal parts. We analyze the kitting process as a two-buffer queueing model. In such system, the parts arrive at a buffer and wait until they are collected into a kit. Each of the two types of parts are necessary to compose one kit, such that kitting blocks when one of the buffers is empty.

II. Methodology

We model the kitting process as a (Continuous Time) Markov Chain with a multidimensional state space which describes all possible inventory levels. While the state space of the chain is large, the number of possible state transitions from any specific state is limited. This means that most of the entries in the transition matrix are zero, i.e. a sparse matrix. Techniques to define and solve sparse matrices (e.g. the generalized minimal residual method) are applied and yield performance measures — like mean buffer content, blocking probability of the kitting process, etc. — of the kitting process at hand fast. For example, Figure 1 shows the probability that one of the two buffers is empty (which corresponds to blocking of the kitting process) versus the buffer capacity for three models. The first model does not consider temporary interruptions in the production whereas the second model accounts for interruptions for part one and the third for both parts. As can be seen, Model 3 has the largest probability to have one of the buffers empty, then Model 2 and finally Model 1. However, the difference decreases as the capacity increases.

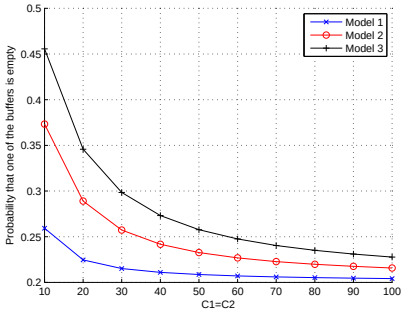

Figure 1. Probability that one of the buffers is empty

III. Conclusions

We constructed a queueing model for kitting processes. Sparse matrix techniques were applied which yield various performance measures of interest fast. Our model can be used to dimension part inventories for kitting processes.

References

[1] Y.A. Bozer and L.F. McGinnis, *Kitting versus line stocking: A conceptual framework and a descriptive model*, International Journal of Production Economics, 25: 1–19, 1992.