**The impact of production interruptions on kitting, an analytical study**

1. Introduction

Nowadays customers put a lot of pressure on the market to afford custom-made products, leading to an increased amount of units on the shop floor. Hence, efficient transport of input materials between the different stages of the production process is a key issue for overall production cost minimization. In this viewpoint, the kitting process was introduced.

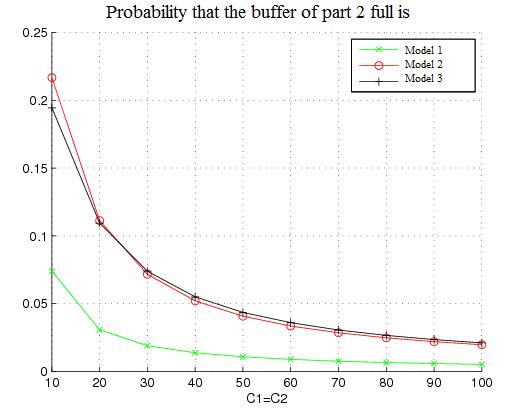
Instead of delivering parts at the assembly line in containers of equal parts, in kitting prior to arriving at an assembly unit the necessary parts are collected into a specific container, referred to as “kit”. A kit is then a specific collection of components and/or subassemblies that together support one or more assembly operations for a given product or shop order [Bozer and McGinnis, 1992].

Although kitting is a non-value adding activity, its application can reduce the overall materials handling time [Ramakrishnan and Krishnamurthy, 2008]. However, the introduction of a kitting operation involves a major investment. Therefore it is important to analyze the performance of the kitting operation in a production environment prior to the actual introduction of this operation.

This paper analyzes the kitting process constructed as a two queue kitting model in an stochastic assembly system. The parts arrive at the part buffers and “wait” there till they are collected into a kit. The aim is to study the impact of interruptions in the production of parts in a kitting process. Therefore,

1. Methodology

We modeled the kitting process as a (Continuous Time) Markov Chain with a multidimensional state space. However, since a finite-buffer-capacity is assumed, the number of possible state transitions from any specific state is limited. This means that most of the entries in the matrix are zero: the transition matrix is considered as sparse. Techniques to draw/set up and solve sparse matrices (e.g. the generalized minimal residual method) were used and performed well in terms of solution speed and results accuracy. Some remarkable results are depicted on figure 1.



On the graph three models are drawn: the first one doesn’t take temporary interruptions in the production into account, in the second model part one is subject to temporary interruptions and finally in the last one both parts are experiencing it. The probability that the second part buffer full is, is illustrated.

A first obvious observation is that temporary interruptions in the production have a significant impact on the performance of a kitting process: the chance that the buffer will be full is higher, leading to a higher probability loss shortage or excess of component. A second observation is that the addition of temporary production interruptions of component 1 are having a significant impact on the behavior of the second buffer. When both parts are experiencing production inefficiency, this do not significantly impact the full-probability chance of the second buffer.

**OBSERVATIES**

First, we can observe that the more capacity there is in both buffers, the smaller the probability that the second buffer will be full and that for all three models. Secondly, temporary interruptions in the production have a negative impact on the performance of a kitting process: the chance that the buffer will be full is higher, leading to a higher probability of loss. Thirdly, modeling temporary production interruptions of the parts of type one has a significant impact on the behavior of the second buffer. This is less the case on the first buffer. Finally, when both parts are experiencing production inefficiency, this do not significantly impact the full-probability chance of the second buffer.

**PARAMETERS**

The parameters are defined in order to enable a significant difference in performance between the kitting models.