Chapter 11

Multi-Product CONWIP System Performance Analysis:
Modeling and Analysis

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ABSTRACT

The increasingly competitive and volatile market requires an adequate production management system to develop customized and unique products quickly and at the lowest possible cost to meet customer needs. The main aim of this chapter is to design a simulation model for studying the behavior patterns of selected performance measures, including mean cycle time, throughput, and mean utilization at different CONWIP levels. The closed queuing network (CQN) mathematical framework is employed to design the simulation model, which is further solved by the mean value analysis (MVA) algorithm. Additionally, the proposed model is simulated using ARENA simulation software to find the adequacy of the results obtained from the algorithm. Finally, sensitivity analysis is performed to assess the performance of the CONWIP-based manufacturing system for various inputs to select the best al-

DOI: 10.4018/979-8-3693-5912-9.ch011

ternative and determine which one provides the best solution.

INTRODUCTION

Organizations are endeavouring to achieve high productivity, reduced lead times, and efficient resource utilization in the current dynamic and competitive manufacturing scenario. The management of manufacturing operations is further intricate by the production of multiple product variants. Effective production control methods are essential for addressing these problems (Prakash & Chin, 2014). A hybrid push/pull production control system known as Constant Work-In-Process (CONWIP) has received a lot of attention from both industry and academia (Romagnoli, 2015; Jaegler et al., 2021). Spearman et al. first proposed CONWIP as a pull-based alternative to Kanban for serial production lines in 1990 (Spearman et al., 1990). According to Framinan et al. (2003), the CONWIP system is intended to control and manage the flow of work-in-process materials in a production line to optimize overall system performance, increase throughput, and reduce lead times. CONWIP, in contrast to conventional push/pull-based systems, permits greater adaptability to shifts in customer demand and production requirements (Spearman et al., 1990).

The use of CONWIP has been investigated in the literature over the past few decades to increase operational efficiency in a variety of manufacturing settings, demonstrating its effectiveness in doing so (Spearman et al., 2022). However, most research has concentrated on card design and job sequencing, leaving out some crucial implementation choices, such as lot sizing. Moreover, Thurer et al. (2014) state that there is currently an absence of literature regarding the relative significance of different implementation decisions on the system's performance. The implementation of CONWIP has also been studied in complicated production contexts such as semiconductor end-of-line assembly and flexible job shops. According to these studies, CONWIP can be a useful tool for production planning and control in challenging scenarios with a high volume and mix of products and significant processing time variations (Jaegler et al., 2021).

A multi-product constant work-in-process (CONWIP) manufacturing system employs multiple stages or workstations to produce a variety of goods. These systems offer the basic purpose of keeping a constant WIP inventory level while maximizing throughput and minimizing lead times. This policy has been proven to bring several benefits over traditional push- or pull-based strategies in production control, especially in HMLV manufacturing situations in which product variety and customization are paramount (Prakash & Chin, 2014).

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