

# Chapter 4

## On Designing Robust Kanban Production Control Strategies in Multiproduct Manufacturing Environments

**Oladipupo Olaitan**

*Dublin City University, Ireland*

**Anna Rotondo**

*Dublin City University, Ireland*

**Paul Young**

*Dublin City University, Ireland*

**John Geraghty**

*Dublin City University, Ireland*

### ABSTRACT

*In this chapter, two Kanban Allocation Policies, Shared (S-KAP) and Dedicated (D-KAP), are analysed to understand how they would perform under different manufacturing scenarios, and the authors identify the merits and demerits of each. To evaluate the performance, a three-stage two product system was simulated under scenarios that provide for different levels of demand variability for each product. When operated under S-KAP, the system contained less Work In Progress (WIP); however, under D-KAP, the system provided more robust service levels as the variability increased. Based on the results from the model, guidelines on how to effectively combine these two policies to achieve the benefits of both in a multiproduct manufacturing system are developed. By partitioning the system at locations that would suit the transformation from one policy to another in a similar fashion to what is obtained in hybrid push-pull strategies, and deploying the policies that match the dominant characteristics at each segment, gives reduced WIP while maintaining service levels.*

### INTRODUCTION

This chapter presents the results of a research study into the design of robust Kanban production control strategies based on a Hybrid Kanban Allocation policy in complex multiproduct

manufacturing environments. It is intended to provide a guide to line design practitioners faced with the diversities and complexities that exist when more than one product is manufactured in a manufacturing system. With the advent of rapidly reconfigurable systems that are capable

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of manufacturing various products in a single production line and increased frequency of new product introduction, new products must often be manufactured on a line before older products they will eventually replace are withdrawn. The contrast in the stages of life cycle of these two products that are being manufactured concurrently always results in significant differences in their demand profiles, and most especially the variability of their demands. Kanban production control strategies, although mostly known to be suitable to low variability conditions, have some variants developed over the years and have been gainfully applied in high variability environments.

This work focusses on the Shared (S-KAP) and Dedicated (D-KAP) card allocation policies (Baynat, Buzacott, & Dallery, 2002) of Extended Kanban Control Strategy (EKCS), investigating their performance under conditions where products with varying levels of demand variability are manufactured on the same line. The results of a previous study showed that the response of manufacturing systems to these two card allocation policies varied according to the level of disparity in the demand profiles of the different products (Olaitan & Geraghty, 2013). It was particularly evident that sharing of cards tends to achieve lesser work in progress (WIP), albeit at the expense of strategy robustness. In this case, robustness is defined as the ability of a strategy to remain consistent in meeting customer demands under conditions of system instability.

Further investigations of these two Kanban allocation policies at different levels of disparity in product demand attributes form the basis of this chapter. Rather than seeking a specific optimal solution which may only apply to a specific scenario, this work concentrates on investigating the robustness of the different policies through sensitivity analysis. This provides more detailed insight into the benefits and drawbacks of the different policies.

Ultimately, the outcome is the development of a Hybrid Kanban Allocation policy, suitable for multiproduct manufacturing environments, with

recommendations to line designers on when each of the policies is suitable for different segments of large multiproduct manufacturing systems.

## **BACKGROUND**

The development of lean manufacturing philosophy led to the introduction of pull based manufacturing where product is only produced to meet a specific demand. This form of control was relatively easily applied to stable single product lines however its effective application in today's more flexible multi-product systems with variable demand requires significant effort. This section reviews the development of pull production control strategies (PPCS) to address such challenges.

### **Pull Production Control Strategies**

Kanban (KCS) is probably the best known component of the JIT-Lean Manufacturing approach, implementing pull control through the use of signal cards, known as Kanbans, to authorise the processing of parts at each stage of manufacture. This effectively limits the level of WIP in the line and, if optimised, results in savings from both the reduced material in the system and reduced congestion. However, since other elements (e.g. total quality control, set up time reduction, and worker participation) are required to ensure that any PPCS can function, they become sources of instability to a system that need to be controlled before a PPCS can be fully applied to a system (Spearman, Woodruff, & Hopp, 1990).

PPCS are traditionally known to be suited to high reliability processes, low setup times, and low variability systems (Gurgur & Altiook, 2007). However, since the introduction of the original Toyota Production Strategy (TPS), new variations of PPCSs, such as CONWIP (Spearman et al., 1990), Extended Kanban Control Strategy (EKCS) (Dallery & Liberopoulos, 2000), Generalised Kanban Control Strategy (GKCS) (Buzacott, 1989) and (Zipkin, 1989), Hybrid CONWIP/Kan-

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