8 Behaviour of MRP, Kanban, CONWIP and DBR under dynamic environmental variability

Klaus Altendorfer, Andreas Huber, Herbert Jodlbauer

Abstract

The choice of a Production Planning and Control (PPC) method can be classified as strategic and the required continuous parameterisation issues as tactical. This continuous parameterisation after implementation of a PPC system is often ignored because it requires planning expertise and is time consuming. The effect of not fulfilling these tactical issues, which results in not adapting the PPC parameters to changed environmental influences, is evaluated in this study. Therefore the behaviour of Material Requirements Planning (MRP), Kanban, Constant Work in Process (CONWIP) and Drum Buffer Rope (DBR) under dynamic environments is evaluated in a simulation model, where a high service level at a low WIP is defined as desirable. The environment is described by means of variability of Mean Time To Repair (MTTR), setup time, machine availability, scrap rate and demand.

This paper can support industrial practitioners both in their choice of a specific PPC strategy and decide if continuous adaptation of PPC parameters is necessary in their production system as well as what critical changes in the environment have to be considered.

8.1 Introduction

The performance of production planning and control (PPC) strategies in different environments, where each strategy is optimised according to certain performance criteria, was widely discussed in literature. Huang et al\(^1\) compared MRP, Kanban and CONWIP in a cold rolling plant. Takahashi et al\(^2\) found that complex supply chains encourage Kanban implementations more than CONWIP. Koh and Bulfin\(^3\) used analytical procedures to track down differences between DBR and CONWIP under stochastic processing times. Information about preferable systems under certain conditions is of special interest in stable environments where changes of environmental parameters either do not occur or occur in such a manner that PPC parameters can be readjusted.

\(^1\) Huang et al. (1998)  
\(^2\) Takahashi et al. (2005)  
\(^3\) Koh, Bulfin (2004)
Unfortunately, manufacturers find themselves in situations where environmental parameters are not stable. In many cases, the manufacturer himself is the trigger of changes, for instance because of continuous improvement activities or changes in product design. The innovative aspect of this paper is that four PPC strategies are first optimised in a reference environment, this can be assumed as the environment the PPC system is initially installed in, and then compared under changes in the environmental influences. The optimised performance parameter is service level at a certain level of inventory. Therefore, a higher service level at the same level of WIP leads to a better system performance.

In this work a flow shop containing a divergent bill of materials (BOM) structure with 10 final products and 6 machines is evaluated. The environment is described by means of variability of MTTR, setup time, machine availability, scrap rate and demand, which usually degrades the performance of a production system. Basics on variability of environmental influences are provided by Hopp and Spearman\(^4\). There are two ways in which the environment can change, i.e. an increase or decrease of variability which have different influences on the system performance. Both situations are discussed in this work.

Before starting to study the system response to changes, the PPC strategies require proper parameter adjustment to reach the best possible performance in the reference environment. This adjustment is found with the help of an evolutionary algorithm within the simulation model. The result is a system characteristic curve for each PPC strategy where the service level is depicted over inventory. Having achieved near-optimal solutions for the PPC parameters, the performance in the reference environment is used for comparison to the performance when considering a certain change of variability. This relative change in performance is considered as the robustness of a certain PPC strategy.

### 8.2 PPC strategy review

PPC strategies are used for the purpose of handling the trade-off between service level and inventory. Assuming that variability of environmental influences does not play a decisive role, PPC strategies need not to be taken into consideration to a great extent. However, this assumption does not usually hold. When variability of environmental influences becomes an issue, frameworks have to be used which make it possible to control performance measures of interest. It is for this reason that manufacturers introduce PPC systems. The performances of these systems vary depending on the environment. The following paragraph provides an overview of the workings and preferences of PPC strategies considered in this paper.

\(^4\) Hopp, Spearman (1996)