Stochastic Modelling in Production Planning

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Methods for Improvement and Investigations on Production System Behaviour

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Preface

All the work presented henceforth was conducted during my time as Research Assistant at the School of Management at the University of Applied Sciences Upper Austria. Additionally, the PhD Management Programme of the faculty of business, economics and statistics of the University of Vienna has been completed. The following funded projects have enabled the preparation of the thesis:

E-Conwip: Embedded Conwip, Austrian Research Promotion Agency (FFG), Project number: 814303/13129, Investigates the production planning method Conwip in an MRPII setting by applying in-depth case studies in three companies.

HPP: Hierarchical Production Planning, Austrian Science Fund (FWF), Translational research project, Project number: L534-N13, Investigation of robust planning strategies in a hierarchical production planning setting.

SimGen: Simulationgenerator, FFG Coin Aufbau, Project number: 826789, Development of a framework for generating discrete event simulation models; decision support for mid-term capacity planning; identifying the effects of planning strategies and their parameters on real world production systems.

ProdNET: Atmende Produktion BAY-AUT, Interreg Bayern – Österreich, Project number: J00317, Identification and promotion of production potential for small and mid-sized enterprises.

HOPL: Heuristic Optimization in Production and Logistics, FFG COMET, Project number: 843532, The aim of this project is to develop innovative optimisation algorithms based on interacting sub-processes to build the holistic model.

BioBoost: Biomass based energy intermediates boosting biofuel production, FP7, Project number: 282873, The overall objective of BioBoost is to pave the way for de-central conversion of residual biomass to optimised, high energy density carriers, which can be utilised in large scale applications for the synthesis of transportation fuel and chemicals or directly in small-scale combined heat and power plants.

The PhD-thesis has been written under supervision by Prof. Richard F. Hartl (University of Vienna) and evaluated by Prof. Heinrich Kuhn (Catholic University of Eichstätt-Ingolstadt) and Prof. Lars Mönch (University of Hagen). The thesis consists of five journal articles, two of which have already been published and three are working papers:

Chapter 3 : Hübl and Jodlbauer (2013): Optimal Utilization based on costs and revenue for a hierarchical decision model based on JIT goals (Working Paper)

Chapter 4 : Altendorfer et al. (2014): Periodical capacity setting methods for make-to-order multi-machine production systems (published) and Hübl and Altendorfer (2014b): Queuing model for optimal switching point for two capacity levels (Working Paper)

Chapter 5 : Hübl and Altendorfer (2014a): Inventory constraint definition for Conwip in a make-to-order environment – a simulation study (Working paper)

Chapter 6 : Hübl et al. (2013): Influence of dispatching rules on average production lead time for multi-stage production systems (published)

The applied simulation model was published in Hübl et al. (2011), Felberbauer et al. (2012) and Altendorfer et al. (2013). Preliminary work has been published in the following conference papers: Hübl and Gmainer (2008); Hübl and Jodlbauer (2008); Hübl et al. (2009, 2010); Hübl (2014); Hübl and Altendorfer (2015).

Alexander Hübl
Wels, March 2015

The PhD thesis has been published by Springer within the FTI (Förderung der wirtschaftlich – technischen Forschung, Technologieentwicklung und Innovation in Oberösterreich) policy of the federal government of Upper Austria for the reserach field "Supply Chain Planning" of Logistikum, University of Applied Sciences Upper Austria. I'd like to give special thanks to my co-authors of the published articles for their inspiration and to Erika for proofreading this book.

Alexander Hübl
Wels, April 2017

Abstract

In this thesis models for production planning are developed and performance indicators are analysed to investigate production system behaviour. Existing literature is extended by considering uncertainty of customer required lead time and processing times and by increasing the complexity of multi-machine multi-items production models.

Results are on the one hand a decision support system for determining capacity and the further development of the production planning method Conwip and on the other hand the JIT intensity has been developed and the effects of dispatching rules on production lead time are analytically proven. The decision support system for determining the capacity provided is based on the capacity demanded, whereby process and/or customer uncertainty can be included. The production planning method Conwip has been extended by including safety stock and by extending the inventory constraint to sum of WIP (Work-In-Process) and FGI (Finished Goods Inventory) and not only WIP. JIT-intensity measures the degree of fulfilment of the "seven zeros" in a production system. A high JIT intensity leads to an increase of excess capacity and to a reduction of utilisation and means that the production system follows the customer demand fluctuations without any "seven zeros"-relevant losses. Consequently, management has the opportunity to increase sales by selling more customer required items or to reduce excess capacity. Finally, the effects of dispatching rules on average production lead time are investigated. An analytic relationship between "processing time weighted average production lead time" and covariance between processing time and queuing time has been identified. This relationship has been proven analytically for single-machine production systems. It has been found out that the "processing time weighted average production lead time" for a multi-machine production system is not invariant with respect to the applied dispatching rule.

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