Proceedings of the 2023 Winter Simulation Conference
C. G. Corlu, S. R. Hunter, H. Lam, B. S. Onggo, J. Shortle, and B. Biller, eds.

A SIMULATION-BASED APPROACH FOR EVALUATING DIFFERENT MODEL MIXES FOR PRODUCTION PLANNING OF A CONTRACT MANUFACTURER IN THE AUTOMOTIVE INDUSTRY

Simon Gruber
Clemens Gutschi
Nikolaus Furian
Siegfried Vössner

Department of Engineering- and Business Informatics
Graz University of Technology
Kopernikusgasse 24
Graz, 8010, AUSTRIA

ABSTRACT

Contract manufacturers face challenges with short-term orders, cost pressures, and diverse customer requirements. Customer trends in the automotive industry intensify these challenges with reduced batch sizes and individual customization. Traditional analytic planning methods are insufficient for handling the complexity of modern manufacturing processes. Computational power alone cannot overcome this obstacle, careful modeling of production processes and resources is essential. Simulative approaches have been developed to address similar problems. In this use case, we aim to adapt and implement these approaches for a leading automotive contract manufacturer. A comprehensive assessment will then verify the adapted approach's viability and potential.

1 INTRODUCTION

The automotive industry is undergoing a significant shift, moving from larger batch sizes to highly customized, smaller batch production, even down to lot-size-one. This change demands greater adaptability and flexibility in production and planning. Contract manufacturers face particular challenges, as they must meet diverse production requirements from multiple customers. To address this, an efficient production planning and control (PPC) system is crucial for success. Following Stevenson et al. (2005) key aspects of such a system include reducing tied-up capital, material requirements planning, capacity planning, and order scheduling. With the growing complexity due to increased individualization demands, conventional PPC methods fall short. According to Jeon and Kim (2016) simulation emerges as the most effective tool to manage this complexity, allowing the exploration of current and future scenarios, identifying potential difficulties and bottlenecks, which are vital for PPC tasks.

2 USE CASE

For this case study, a problem on the Enterprise Resource Planning (ERP) level is considered and therefore the level of detail of the simulation model is low. This means that the production flow (network graph) only considers productions halls, as black boxes, thus production stations and machines are not modelled explicitly. The network graph abstracts the multi-stage production process (see Figure 1) in which each car must pass through all functional areas with the restriction that each model may only be routed through one of the parallel production halls. Body in white consists of 1 to n production halls that can be linked in parallel and in series. Paint consists of only one hall through which all produced cars must pass and assembly consists of 1 to m parallel halls. The production halls exhibit varying job frequencies per hour, and the shift models employed can also differ. Moreover, in the manufacturing process, buffers are incorporated both before and after each functional unit.

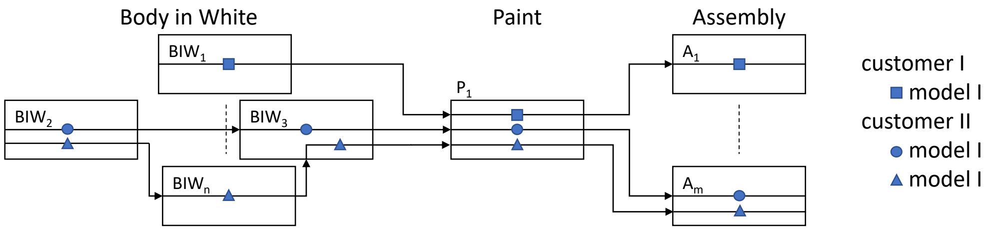

Figure 1: Example structure of the production line.

The open soure simulation tool Jaam Sim was used for a first approach to maximize production quantity in standard working hours and for risk reduction of over and under utilization of the production halls. In the further course of the project, however, this software will be replaced by commercial grade software due to the required level of detail. This case study describes the program planning process used by the contract manufacturer which works as follows. Each customer is required to provide a certain quantity of monthly units (cars) two months in advance. The quantity of cars further consists of a mix of different models, whose distribution is restricted by the contract manufacturer. The models further consist of different variants e.g. equipment, but at this stage of planning these variants are unknown. In the next step the planner has to decide if the quantity is feasible to be produced in one month with the given shift model. This decision relies heavily on the experience of the planner and in most cases the production quantity entails extra shifts. As a next step the planner has to split up the monthly quantity of cars and models into a weekly quantity and calculate the quantity for each department evolved in the production process under consideration of fulfilling the buffer quantity's that are needed for the uncertainty of not knowing the variants of the models. The complexity of this task highly depends on the number of different customers and associated models, this is due to the network graph which is getting more branches with each new model and therefore gets more complex. To handle this complexity we use a discrete event simulation, which checks the feasibility of the production and detects bottlenecks in the network graph of the production. The simulation model uses the quantity and distribution of the models, jobs per hour of the production halls, net working time, the shift model and the network graph of the production as an input. In the scenario analysis we simulate different model mixes to test the robustness of the net working time through the balancing of the workload associated to each individual production hall.

3 RESULTS

The simulation model simplifies planning by abstracting the company's operations. This approach lowers the complexity of planning tasks, allowing faster identification of production feasibility and bottlenecks for a given quantity. If production is infeasible, the planner receives information on the additional net working time needed to achieve feasibility, aiding decision-making for overtime or extra shifts. The simulation enables maximizing shifts and minimizing under/over-utilization risks. Future improvements involve expanding and refining the simulation model to simulate sequence of variants, daily unit numbers and variants, optimizing buffer sizes, and reducing tied-up capital.

REFERENCES

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