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Production planning to support mixed-model assembly☆

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Abstract

A mixed-model assembly line is widely used nowadays in industry. Effectively applying mixed-model assembly can result in smooth part usage and balanced workloads on the assembly line. The problem of production planning in terms of scheduling various models on an assembly line over a time horizon is studied here. The problem assumes that each model has a given range of production days within the planning horizon. An industrial production system is presented to demonstrate the application of this problem. A two-phase procedure that generates an initial solution and makes further improvement is developed. The procedure is evaluated using randomly generated problems and an industrial example.

Keywords: Mixed-model assembly; Just-in-time; Production planning

1. Introduction

The conventional way of assembling various models of finished products in a manufacturing plant is to produce them in batches. The just-in-time (JIT) production concept suggests that a level, mixed-model production schedule be repeated daily on an assembly line (Monden, 1983). A level, mixed-model production schedule gives such advantages as smooth materials requirement, more balanced work loads on the assembly line, and better delivery performance in meeting the demands of various models.

To effectively manage a mixed-model assembly line, problems to be addressed include line balancing (e.g., Macaskill, 1972; Thompoulos, 1967) and determining the sequence of producing different models on the line (e.g., Cheng & Ding, 1996; Inman & Bulfin, 1991; Okamura & Yamashina, 1979; Miltenburg, 1989). The problem studied here regards how to evenly schedule the production quantities of all models among the time periods in a planning horizon for a mixed-model assembly line. This

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scheduling (or production planning) problem needs to be addressed prior to sequencing a mixed-model assembly line.

Assume that the demands of various models are known during a planning horizon. For a mixed-model assembly line, the quantity of each model to be produced in each time period (such as a day or a shift) needs to be determined. In a simple case where the only condition is to meet the total required production quantities within the planning horizon, scheduling various models can be done by evenly distributing the required units of each model to all time periods in the planning horizon. The problem becomes more complicated if it includes an objective of having level production among all time periods and the additional constraints regarding certain feasible time periods for producing various models.

Consider n models to be assembled on an assembly line. Within a planning horizon (e.g., a month or two weeks) that consists of m working periods (e.g., days or shifts), a total quantity q_i of each model i will be produced on the mixed-model assembly line. It is further assumed that within the planning horizon, model i can be scheduled only within a range of days A_i to B_i. The production scheduling (or planning) problem studied here is thus to develop a smooth production schedule of all models within the planning horizon while meeting the total production requirements. The smoothness of the schedule will be evaluated based on the variation from the average overall quantity per time period and from the average quantity per time period of each model. Various weights can also be assigned to various models, and different target production quantities for various time periods can be further assumed.

1.1. An industrial example

A manufacturing firm located in the U.S. upper Midwest produces 22 models of skid-steer loaders on a mixed-model assembly line every day. A skid-steer loader is a multi-purpose four-wheel-drive vehicle with left and right sides independently driven. A typical product is shown in Fig. 1. A skid-steer loader can be equipped with various attachments and is a very useful tool in construction, agriculture, and

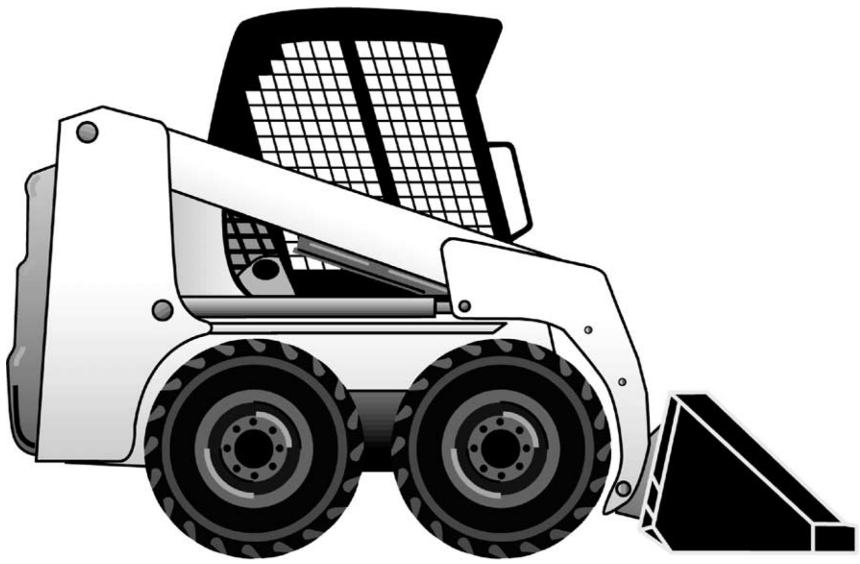

Fig. 1. A typical skid-steer loader.