OPTIMAL REACTIVE SCHEDULING FOR JOB SHOP, MAKE-TO-ORDER INDUSTRIES: A MOULD MAKING INDUSTRY CASE STUDY

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Industrial environments are dynamic in nature and disturbances in the daily operation of the plant such as machine failures, processing time delays, arrival of new orders and unavailable material may cause a predetermined schedule to become inefficient or even infeasible. In real-time, the ability to rapidly react to such unexpected events and revise the schedule in an effective way (reactive scheduling) is thus as important as the scheduling problem itself.

Starting in the 1950s, a great deal of effort has been spent developing methods to generate optimal or near-optimal production schedules, yet interest in reactive scheduling techniques intensified only in the last decade.

In this paper a new approach for reactive scheduling of job shop, make-to-order industries is presented. A mixed-integer linear programming (MILP) model for job shop scheduling is derived with a view to its application in a dynamic context. Treatment of time is continuous, as opposed to discrete time models. The model is embedded in a reactive scheduling algorithm that shifts the scheduling horizon and solves the model iteratively to take account of changes in the system. One of the situations modelled is that of inserting new orders in the production schedule, an important and challenging problem in order-driven industries.

In the present approach the extent of the schedule changes may be controlled by the user with the definition of the subset of orders that may be rescheduled in each iteration of the algorithm, leaving the others unchanged. Additionally, further constraints may be added to the MILP model to limit changes in the operations previously scheduled. Solution continuity and system stability are thus preserved, an important issue in dynamic production environments where shop floor nervousness is undesirable.

The approach is illustrated by the solution of a mould making industry case study. This is an important industry in the context of the Portuguese economy. Mould makers operate in a job shop, make-to-order basis, producing one-of-a-kind products. Specific features of the mould making process, such as recirculation and assembly, are taken into account. Recirculation in a job shop occurs when certain jobs visit some machines more than once. In mould making, the process of carving a cavity has to be divided into stages due to the need of intermediate operations, hence implying recirculation. Also, moulds generally consist of a few large and other more numerous small parts, produced separately and assembled in the final stage of the process. Both recirculation and assembly, which have received scant treatment in the scheduling literature so far, are considered in the proposed MILP model.