Simulation-based optimization in make-to-order production: Resource leveling for a special-purpose glass manufacturer

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We consider a production planning problem that arises in make-to-order production of a company specialized in treatment, shape modification and coating of special-purpose glasses. Due to the sensitive raw material and high quality specifications, the company's multi-stage manufacturing process is greatly affected by stochastic processing times and scrap rates. As production levels and product mix change frequently over time, smooth utilization of resources and simultaneously meeting of customer delivery dates are often not achieved. Consequently, undesirable effects result, e.g. costs for overtime and additional staff. The problem at hand consists of scheduling production orders under uncertainty in order to minimize variability in resource utilization over time. In addition to scarce resources like machines or manpower, specific material handling constraints have to be taken into account, which are caused by heavy and bulky products (e.g. large displays).
Against the background of the company's dynamic and complex production environment, discrete-event simulation (DES) represents an effective tool for analyzing the impact of alternative scheduling policies and resource configurations, but it fails in efficiently guiding the search for optimal control parameters, e.g. schedules of production orders that take the resource leveling objective into account.
To overcome this drawback, we propose a simulation-based proactive-reactive optimization approach. While robust baseline schedules are obtained from the solution of a mixed-integer-programming model (MIP), additional reactive rescheduling techniques are embedded into simulation to cope with uncertainties, e.g. stochastic processing times. We illustrate the interaction of the MIP model and the DES model and present preliminary results indicating the effectiveness of our approach.