# Shift Scheduling in Interdependent Multi-stage Systems with Reallocation of Workforce

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**Abstract.** Many manufacturing and logistic systems (e.g., distribution centers) consist of serially organized stages. In each of these stages, a process is performed on each item of the demand (e.g., picking, consolidation/packing, and shipping in a distribution center). The number of items to be processed at each stage depends on the demand pattern and the assigned capacity to the predecessor stages. Hence, the capacity decisions for the stages are interdependent in such systems. We model the shift scheduling problem in systems with serially organized stages. We consider a daily planning horizon with a multi-skilled workforce who can be reallocated multiple times during their shifts. Each reallocation between stages results in a loss of capacity at the destination stage. The objective is to minimize the total workforce costs. We propose a column-generation algorithm to solve the problem. We solve various realistic instances to test the effectiveness of the proposed algorithm. Our results show that scheduling the shifts independently for stages will either result in suboptimal or infeasible solutions. We also show that taking into account the interdependency among the stages helps better utilize the reallocation flexibility.

**Keywords:** Shift Scheduling · Multi-skilled workforce · Worker Reallocation · Multi-stage systems